Discourses of Ability and Primary School Mathematics
Production, Reproduction and Transformation

Marks, Rachel

Awarding institution:
King's College London

Title: Discourses of Ability and Primary School Mathematics
Production, Reproduction and Transformation

Author: Rachel Marks

Discourses of Ability and Primary School Mathematics: Production, Reproduction and Transformation

Rachel Gwendoline Marks

May 2012

Thesis submitted in fulfilment of the requirements for the degree of

PhD in Mathematics Education

King's College London, University of London

Abstract

This thesis investigates how discourses of mathematical-ability are produced and reproduced by pupils and teachers in the primary classroom and the impacts of these on teaching and learning. Building on a literature base suggesting the often negative and self-fulfilling outcomes of ability labelling and grouping, the thesis embeds this literature strongly in primary mathematics, exploring why these practices not only continue, but form the basis of much Government and school organisational policy.

Utilising a critical realist meta-theory, the thesis draws pragmatically from multiple traditions. Data were collected from approximately 300 pupils and 14 teachers in two primary schools. Individual and group-interviews and classroom observations explored pupils' and teachers' productions of their own and others' mathematical-ability, with pupil questionnaires and attainment tests used to examine the extent to which these impact on pupil attainment and learning in mathematics.

The thesis finds that discourses of ability are pervasive, embedded in all aspects of teaching and learning in primary mathematics, and resistant to change. Pupils and teachers are fairly consistent in their understanding of mathematical-ability; this is thought of as a stable, innate quality connected to intelligence and genetics or else conceptualised in terms of, and muddled with, assessment outcomes. Assessment, labelling and inequitable ability practices create pupils from an early age as mathematically able or not, whilst setting places the focus on the mathematics, effectively ignoring the whole-child, raising many of the concerns about setting in secondary mathematics in a primary context. Many teachers recognise the inequity in the practices they engage in, yet reproduce the inequitable practices they experienced. The thesis explores why change is difficult and proposes ways of breaking the cycle of inequity which currently limits many pupils' mathematical attainment and which severely restricts pupils' engagement with the subject.

Acknowledgements

This thesis would not have been possible without the support, help and guidance of a number of people. I owe a great deal of thanks to the staff and pupils at 'Avenue', 'Parkview' and 'Riverside' Primary Schools. Without their willingness to participate in the research, this study could never have been completed.

Dr Jeremy Hodgen supervised both this study and the previous MRes study which provided essential background to this research. He has shown a great deal of commitment to this study and his support has been greatly received. Professor Mike Askew supervised this study between 2006 and 2010. He provided many useful insights and made me think about the issues I was exploring in different ways. I am also grateful to Professor Meg Maguire who stepped in during the final year of this study as my second supervisor, bringing a new perspective to my research.

I am also indebted to other staff and students, past and present, within the Department of Education and Professional Studies at King's, particularly within the Mathematics Educational Research Group. Their support and insight has helped me to move this study forward at many crucial points. In particular I would like to express my thanks to Professor Diana Coben for her ongoing pastoral support throughout my time at King's.

I would not have completed this study without the input of a number of people who have supported me during the last five years. These people know who they are but in particular I would like to take this opportunity to thank Natalie, Claire, Simon, Liz and Celia as well as the dedicated staff at Guy's & St Thomas' Hospitals. Many others have also supported me and are too numerous to name here, but I would like to express my sincere thanks to each and every one of them. Additionally I should thank my sister, Amelia, for her ongoing support, good-humour, generalised mocking of social 'scientists' which forced me into producing a sound justification for my research and multiple outings for sustaining coffee, brownies and totally irrelevant philosophical discussions.

Finally, this study would not have been possible without the financial support I have received. The ESRC funded the study between 2006 and 2010 (award number: PTA-031-2006-00387) and made it possible for me to conduct such a sustained in-depth study. I am also grateful to the following trusts and charities that provided grants to support the final year of this research: The Allan & Nesta Ferguson Charitable Trust, Funds for Women Graduates, The Mike Devenney Scholarship Fund and The Snowdon Award Scheme.

Contents

List of Tables

List of Figures

List of Abbreviations

ASD	*Autistic Spectrum Disorder*	
BSF	*Building Schools for the Future*	BSF was intended to upgrade all secondary school buildings. BSF was terminated in 2010 by the Coalition Government.
BSL	*British Sign Language*	
CAT	*Cognitive Abilities Test*	Numerical, verbal and non-verbal reasoning tests used by schools as indicators of future test performance.
CVA	*Contextual Value Added*	A Government measure of school effectiveness taking into account prior performance and factors known to impact on attainment, e.g. SES and SEN, standardised to 100, with the middle 20% of schools scoring 99.7 to 100.1.
CPD	*Continual Professional Development*	
CR	*Critical Realism*	
DSP	*Designated Special Provision*	A mainstream primary school given additional funds by the Local Authority to provide additional support for pupils with a particular SEN
EAL	*English as an Additional Language*	
ETN	*Effective Teachers of Numeracy (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997)*	
GCSE	*General Certificate of Secondary Education*	Examinations taken by school levers in the UK at the age of 16
HLTA	*Higher Level Teaching Assistant*	
FSM	*Free School Meals*	Pupils from low income families are entitled to receive free school meals. FSM is used as a proxy measure for SES. This is the same measure used in Ofsted inspections and is appropriate when used for comparative purposes only. Concerns in the use of this measure are recognised (i.e. Hobbs & Vignoles, 2010).

INSET	*In Service Education of Teachers*	
IWB	*Interactive White Board*	
KS2	*Key Stage Two*	Pupils in the UK from Year 3 to Year 6, ages 7-11
LNRP	*Leverhulme Numeracy Research Programme*	
NFER	*National Foundation for Educational Research*	
NNS	*National Numeracy Strategy*	
P-CAME	*Primary Cognitive Acceleration in Mathematics Education*	
PCT	*Personal Construct Theory*	
PPA	*Planning, Preparation and Assessment Time*	
QCA	*Qualifications and Curriculum Agency*	Government agency later re-named the Qualifications and Curriculum Development Agency (QCDA) due to be disbanded Autumn 2011.
SA	*School Action*	The first level of additional support given to pupils with SEN involving additional targeted support within school.
SA+	*School Action Plus*	The second level of additional support given to pupils with SEN where SA is not adequate, involving external support services such as educational psychologists.
SATs	*Standard Attainment Tests*	
SEN	*Special Educational Needs*	
SES	*Socio-Economic Status*	
SMT	*Senior Management Team*	
TA	*Teaching Assistant*	
TIMSS	*Trends in International Mathematics and Science Study*	

‘The head-teacher half apologised that the children were singing the old fashioned hymn “All Things Bright and Beautiful” but reassured me that they no longer sang the verse “… the rich man in his castle, the poor man at his gate, God made them high or lowly and ordered their estate”. Yet, metaphorically speaking, in her ostensibly politically correct school it could be said, as in countless other schools, that rich men are indeed still sitting in their castles and the poor at their gates. The junior children are all in streamed classes and the younger ones are streamed within their classes by the familiar recourse to the names of large animals, small pets and primary colours. Children, teachers and parents alike are under no illusion as to the location of the castles and the gates. They all know full well which colour, which pet, which animal, represents those considered “best” at learning. They are also aware of the potential riches accruing to those in the upper streams. The only change is that the Lord is no longer held to be responsible for the way in which such things are ordered and anyway we are told it is not intended for life. But we know and always have known, that streaming is nearly *always* for life.’

(Dixon, 2002, p. 1)

1 Introduction

1.1 Overview and Statement of the Problem

Dixon's quote aptly captures the central issue considered in this thesis, that is, the uses and implications of an ideology of ability in primary mathematics education. Primary school ability-grouping, established through the 1944 Butler Education Act, has a long controversial history (Davies, Hallam, & Ireson, 2003). During the early 1960s, when streaming was the norm, 96% of schools, where feasible, adopted this practice with pupils being streamed from the age of seven through a notion of general intelligence (Jackson, 1964). Whilst the Plowden Committee's report (Plowden, 1967) and concerns over the inequalities of early streaming (Barker Lunn, 1970; Jackson, 1964) saw a move towards mixed-ability teaching, the ideology of ability was never lost.

Ability-grouping has long been proposed as one answer to concerns over standards in school mathematics. The National Curriculum fuelled a resurgence of ability-grouping in primary schools (Sukhnandan & Lee, 1998), previous Government reforms have proposed banding by ability for secondary school pupils and ability-grouping is recommended by the Primary Framework. In a survey of 2000 primary schools, Hallam et al. (2004a) found 52% had made some changes to their grouping at the inception of the National Numeracy Strategy. Through the 1990s and into the 21st century, Government drives to improve standards have brought ability-grouping to the fore (Hallam, 2002). With growing Government pressure, ability is again becoming the dominant grouping criteria in UK schools (e.g. Hamilton & O'Hara, 2011; Ipsos MORI, 2010).

Repeated studies tell us that overall ability-grouping has negligible impact on pupils. Ability-grouping has no overall effect on attainment (Slavin, 1987, 1990). Gains for one group may offset the negative effects on others (Linchevski & Kutscher, 1998), yet there is no consequential effect of ability-grouping on median pupil attainment (Kulik & Kulik, 1982a). Rigid ability-grouping has a detrimental effect on attitudes, particularly for pupils in average and low-ability-groups (Sukhnandan & Lee, 1998); qualitative research on ability-grouping in secondary mathematics seems to collaborate potential negative impacts (Boaler, Wiliam, & Brown, 2000; Zevenbergen, 2005).

Despite this evidence, perceived 'common-sense' appears to prevail and ability-based practices are increasing. Little space is given to understand the concepts underlying these practices and a shared understanding is assumed. Mathematics and general ability labels are applied to pupils and associated practices implemented with little thought to the wider meanings and consequences of such actions. A socially acceptable discourse of individuals being good or not at maths (Povey, 2010) and a societal preoccupation with categorising, grouping, boxing and labelling individuals maintains ability labelling and ability-based school practices as natural and normal. These social understandings appear to be powerful enough to allow us to overlook the consequences and fail to ask questions about what is actually happening, allowing continuity of current practices.

Despite the quantity of research in the area of ability-grouping, gaps exist in the current literature. Much of the literature addressing ability-grouping assumes shared understanding of the underlying terminology. Terms such as ability are occasionally problematized, but studies of their meaning, to those encountering them on a daily basis, are very limited. Without an understanding of what ability is taken to be, it is very difficult to develop our understanding of its powerful and unquestioned position. In addition, many commentaries extrapolate from secondary education studies. The primary school, and primary mathematics, is qualitatively different from the secondary school, making the extrapolation of research findings across phases potentially problematic; we do not know the true impact of an ideology of ability, or how these effects come about, within the primary mathematics context. It is clear that ability-grouping, both within and between classes, has increased dramatically over recent years in the primary school. Despite this, there seems to be, as of yet, very little research into the specific effects this has on primary pupils.

1.2 The English Context

It is important to note early on within this thesis that this study is set within the particular context of the English education system which carries particular caveats in understanding the analysis and discussion and its transferability to other systems. In particular this research was conducted at a time when the Primary Framework – and in relation to its mathematical foundations, the National Numeracy Strategy (NNS) – was a strong influence on teaching and learning in primary mathematics.

The NNS, implemented across English primary schools in 1999, acted as a strong centralising policy with all schools devoting the same time to teaching mathematics and using similar teaching styles and classroom organisation methods (Brown, Askew, Baker, Denvir, & Millett, 1998). One aim of the NNS was to fulfil the attainment targets set down by the then Labour Government for the end of primary education. This led to a shift in focus towards examination outcomes deemed important to the schools. As a result of this the NNS endorsement of differentiation (Askew, Millett, Brown, Rhodes, & Bibby, 2001) may have led towards an increase in ability-grouping in response to this pressure to increase attainment outcomes as schools placed increasing emphasis on those children on the borderline between Level 3 and Level 4.

Whilst the NNS may have led to an increase in ability-grouping, such practices are not new to the UK where the reduced curriculum on offer to some pupils differentiates the UK system from some other countries (Brown, et al., 1998). The UK is somewhat unusual internationally in the extent to which ability grouping by setting, streaming and within-class grouping is practised. The strong ideology and complex history related to the UK use of ability (Hodgen, 2007) is discussed in depth within this thesis, although it is worth noting here that the strongest form of ability based segregation – streaming – appears to be on the rise in primary schools (Hallam, 2011).

Whilst for some countries there is a different overall focus, often on effort rather than ability (Askew, Hodgen, Hossain, & Bretscher, 2010), other countries may not set (between-class grouping) but they do engage in other practices which could be seen as equally iniquitous. Evidence from TIMSS points towards schooling systems where grade retention is relatively high for instance in The Netherlands (Meelissen, 2008) and the United States (Keene, 2008). Other countries have very explicit differential access to courses or schools at the secondary level, for example in Germany (Bonsen, Bos, & Frey, 2008), with allocation usually being to academic or vocational paths. Given the existence of such different systems, it is important to read this thesis as grounded in an English context.

1.3 Significance of the Thesis

This thesis makes a significant contribution to addressing the gaps in the literature outlined at the beginning of this thesis. Being grounded in primary mathematics education it engages with broader views and practices of ability, less restricted by subject or age boundaries or the departmental microcosms that exist in secondary schools (Goodson, 1993; Goodson & Managan, 1995), and secondary education studies. The present study draws on concerns arising from the secondary ability-grouping literature – qualitatively different group interactions (Harlen & Malcolm, 1999; Wiliam & Bartholomew, 2004), and the production of pro and anti-school factions (e.g. Ball, 1981) – and examines the impacts of ability practices within the primary context. Further, this study is distinct in investigating the impact of ability both in terms of attainment and attitude. Very few previous studies have integrated these outcome measures (Hallam, 2002).

This thesis makes a significant contribution to our understanding. It addresses the question of what the main construct – ability – actually means to those using it, going beyond studies which examine just ability-grouping. In doing so I ask why ability is such an embedded concept with such a strong ideology and why it seems so resistant to change. This provides a further contribution to knowledge in exploring the processes underpinning the rejection of research evidence, an issue vital in enhancing research dissemination. Whilst this thesis asks what ability is to those living and working with it in schools (predominantly, but not limited to, teachers and pupils), the thesis is concerned with understanding the impacts of an ideology of ability rather than engaging at a neuro-scientific level with ability as an attribute.

Whilst being situated within mathematics, the impacts and understanding from this study can be applied on a broader scale. As Gates (2006) argues, teachers' beliefs are based on foundations extending far beyond the mathematics taught and the mathematics classroom. This research expands the theoretical and practical literature on effective teaching and learning within and beyond primary mathematics. It will be of interest to the mathematics and wider education communities and potentially to Government policy advisors.

1.4 Research Development

I developed this thesis across academic work spanning seven years. It also builds on my personal and professional interest in the area which has a much longer history. This history, and the influence of my biography, is discussed in Chapter 2. This thesis has its foundations in earlier MA (Marks, 2005) and MRes (Marks, 2006) dissertations.

I began the MA study in 2004 as a means of questioning practices and policies I had been engaged with as a teacher but with which I felt uncomfortable. Academic study did not address these questions but caused me to ask many more and to question many presumptions that I had held as a teacher, particularly in the area of ability. This led to a literature based MA dissertation into the use of ability in numeracy policy documentation which begun to highlight how pervasive ideas and assumptions of ability were throughout education. Taking this further, the empirically based MRes study begun to explore how discourses of ability in primary mathematics could be investigated further.

The current PhD draws heavily on what was learnt, and questions that were raised, during the MRes study, this acting as a first pilot phase. A second pilot phase was conducted during the first year of the PhD to extend and verify modifications made to the research instruments. The literature basis of the study, essential in justifying the need for this research and in identifying the contribution it makes, has developed over these phases although most systematically, and with its own methodology, at all stages within the main PhD study. Likewise, the theoretical underpinnings of this study – a critical realist meta-theory – have also developed across all three studies, from a tentative exploration of critical realism during the MA study and its implications for empirical research during the MRes study, to an in-depth exploration and analysis of the issues across all stages of the PhD study.

1.5 Research Objectives and Questions

Across the three studies, and particularly within the present study, I continually reviewed and refined the objectives of, and questions asked by, the research. The research questions for the PhD were developed from tentative findings from the MRes study and the identification of gaps in the literature.

One gap identified early on and a question I kept coming back to in the previous studies was that of what ability actually is. Many studies seemed to be based on an assumed shared understanding, yet this was never explicated and early literature reviewing and MRes empirical work suggested this to be a concept with many strands and definitions. In some cases, people appeared to be talking about, and thought they were talking about, the same thing in using the language of ability, yet when deconstructed, they were actually talking about different concepts or different strands of the same concept. As such, my first objective was to explore what ability actually was, not in a neuro-scientific sense, although consideration of this literature was important, but in terms of everyday use of the term, particularly in schools and classrooms.

The literature on the effects of ability, particularly ability practices, is particularly strong in secondary education but less so in primary education. Where the literature is primary based, it tends to focus on specific practices rather than attempting to understand the effects of ability as a concept within itself. As such, it was felt important to replicate some aspects of these primary and secondary studies but with the focus on the effects of ability language and its resultant practices more generally, the second objective being to understand the powers of ability and its generative mechanisms.

Taking the effects question further, few studies have examined how the effects noted may have come about other than in relation to basic issues of stratifying practices. This is perhaps due to not taking that earlier step of questioning what ability actually means to those using it on a daily basis and whether individuals' conceptions align. In addressing this, a third objective of the present research was to understand how ability was able to bring about the effects it does.

The three objectives were very open and hence difficult to operationalise. Additionally, they did not take into account the key finding emerging from my MRes study, that of the linkage between actors' productions of ability and the mediation that occurs in coming to develop an understanding of ability and allowing it to have the effects it does. Considering these concerns in light of my developing understanding of critical realism and its key language I began to develop a linear, but interrelated, set of processes through which to explore the issues highlighted in the objectives above: production, reproduction and transformation or transformative-reproduction. As the MRes study highlighted the roles of different actors in developing conceptions of ability I felt it necessary to address the key actors – teachers and pupils – separately, whilst additionally having space to consider the influence of other external actors and groups, for instance parents in the case of pupils or Government policy in the case of teachers.

Taking the above into account, an overarching research question and three sub-questions were produced:

- In what ways is ability produced, reproduced and transformed in the primary mathematics classroom?

- What is the role of pupils in producing, reproducing and transforming their own and others' mathematical-ability?
- What is the role of teachers in the production, reproduction and transformation of pupils' mathematical-ability?
- What effects does ability have on pupils' attainment in and engagement with primary mathematics?

The research questions map onto the three objectives outlined previously as shown in Figure 1 whilst being operationalisable, extending previous work and being produced so as to provide data clearly addressing the previously identified gaps in the literature.

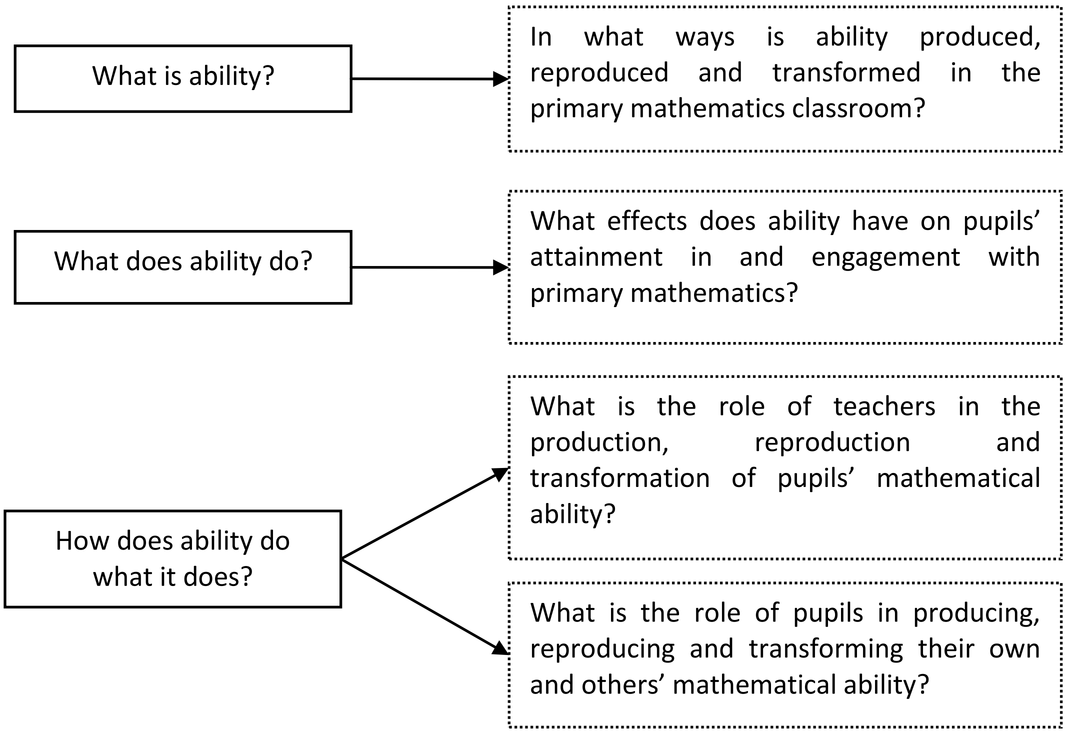


Figure 1: Links between research objectives and research questions

1.6 Research Approach

Building on the earlier studies outlined in section 1.4, this study involved a pilot phase conducted in early 2007 followed by a full year of empirical research for the main study conducted during the academic year 2007-2008. The main study took place in two primary schools – Avenue Primary and Parkview Primary – each of which are described in chapter 5. Avenue set pupils for all mathematics lessons whilst Parkview had predominantly mixed-ability organisational strategies. Within each school I worked with classes and sets in Years

4 (ages 8-9) and 6 (ages 10-11, the final year of primary education). In total the study involved 284 pupils (24 of whom were focal-pupils), 13 classes, and 8 focal-teachers.

The study uses a number of theoretical concepts but predominantly uses a critical realist meta-theory. This approach is discussed in Chapter 2, and my methodological approach considered in Chapter 4. A critical realist position extends the usual realist tenet of a world, one we have an incomplete knowledge of, existing independently of our knowledge of it. Critical realism is able to engage with this reality and begins to make claims about what the world may actually be like, making judgements between competing claims. In doing so, it uses the concept of depth ontology to recognise that the world can be understood and experienced at many different levels of reality. The uptake of critical realism in educational research is fairly new and currently limited, yet it has much to offer, particularly with respect to the issues considered in this thesis. It is able to offer a way of thinking about directly unobservable entities – such as ability – and their powers. Further, and beginning to address some of my concerns which shaped the development of this research, critical realism carries a strong belief in using our developing understanding for emancipatory action. Given that ability seems to be being reproduced as a stigmatising discourse, critical realism potentially provides a way of thinking about change and providing the hope that change is possible.

Critical realism does not provide a method but is open to a wide variety of approaches, allowing methods to be used independently of their theoretical backgrounds. This study used a mixed-methods approach. Quantitative methods – attainment tests and attitudinal questionnaires – were used to explore attitude and attainment across the whole pupil sample in relation to the research questions. Qualitative methods – classroom observations and interviews – were used to allow in-depth exploration of the issues with the focal-pupils and teachers. Each method is described in Chapter 4. Data were triangulated and the emerging themes discussed in relation to the objectives and research questions of the study.

1.6.1 A note on perspective and terminology

In this thesis I have predominantly written in the first person. As noted in section 1.4, this thesis is significant to me and arose from personal and professional concerns. To write myself out of this thesis would be to dismiss my impact on the data collected and to, as Ball (1990) suggests, deny the impact of my presence on the research.

A number of terms are used within this thesis which carry specific meanings for some people or which have specific connotations within different theoretical perspectives. The major terms – discourse and identity – are clarified in chapter 2 where I explain how they are used within this study. The main term underlying this thesis – ability – may be a contentious term. Some researchers have attempted to ameliorate concerns surrounding the use of ability and associated language such as intelligence by noting its potential difficulties and presenting every instance of the word in quotation marks. Whilst this highlights the language as problematic, it can also make the writing messy without addressing the underlying issue. I debate the use of ability in chapter 3 and how I have developed an understanding for myself across this study. For clarity, I do not present ability within quotation marks but as one objective of this research was to find out what ability actually means to different people, it should be assumed that the term is continually problematized throughout the writing.

1.7 Thesis Outline

This thesis is not presented in the order it was undertaken or written, a process which involved moving back and forth between elements in attempting to coherently present the research and the stories the data tells. Instead, the thesis is presented in a linear fashion, providing the clearest pathway through its elements. Following a common structure, the thesis presents the research questions in the context of the current literature and thesis framing, the methodology and methods, data analysis and findings. Figure 2 shows each element of the research process and indicates how the linear order of the chapters maps on to these processes. The chapter sequence indicates the main components of each chapter suggesting how they follow and support each other to make up the complete thesis.

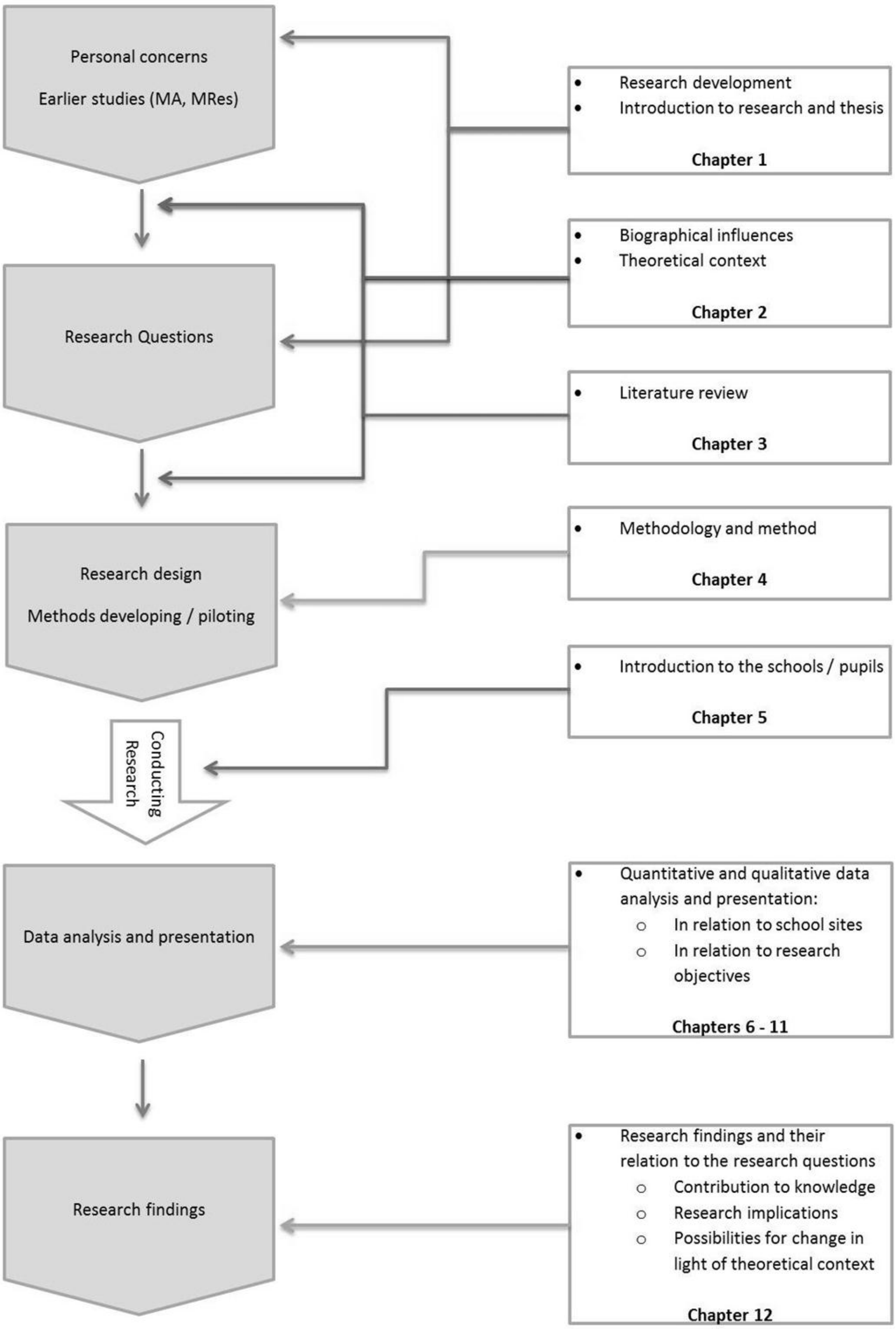


Figure 2: Sequential order of thesis

2 Situating the Thesis

Having introduced and outlined the research, this chapter sets out the theoretical and personal background. It explains how the thesis came to be and the impact of this journey on the outcomes of this thesis. It explains the ontological and epistemological stance used and the changing role this has taken as well as setting out how the key terms of this thesis – discourse and identity – are understood.

2.1 Introduction

Knowing the position a researcher takes on truth and knowledge is essential in understanding how the research was conducted and why it was conducted as it was. Understanding the position taken helps the reader follow the path of the research, comprehend the decisions made and think about the findings in light of their own epistemological and ontological stance. Addressing this, I discuss the development and use of a critical realist meta-theory.[1] I examine the critical realist position and its fit with other philosophical positions. I outline the development of critical realism within educational studies before focussing on how it is used within this research. In addition to critical realism, I regularly refer to discourse and identity. Terms such as these carry different meanings to people hearing them based on different theoretical perspectives. Given this, this chapter sets out how these terms are used in this thesis and the boundaries placed around their use.

Ball (1990) has argued for a consideration of the researcher's self and their social relations in fieldwork. It may help to explain why particular theoretical positions were taken, why the research was conducted as it was and why the researcher has formed the understandings they have. As I stated in Chapter 1, I developed this thesis over a substantial period of time with it building on my experiences as a teacher and learner. Awareness of this background is important in understanding where the research interest came from and how the research developed. As such, I begin this chapter with what

[1] Meta-theory is used as opposed to philosophy or a separate discussion of ontology and epistemology because the position I take embraces both elements. However, the two are not conflated within a meta-theory as to do so would be to fall into the epistemic fallacy critical realism warns against.

Mendick (2006, p. 10) terms a 'fragment of autobiography', allowing the reader to understand my perspective.

2.2 The Researcher: Motivation and Reflexivity

> 'In the same way that we would not expect to read a quantitative research report without some idea of the instruments employed to collect data, we should not expect to read qualitative research without some idea of the instrument employed – the researcher herself or himself.' (Ball, 1990, p. 170)

The article from which this quote is taken concerns reporting ethnography, yet Ball's call for understanding the researcher is applicable to all qualitative research. This emphasises the need to consider the impact the self has on the research and to present something of this so the reader can understand the various influences on the conduct of the research. Further, Ball defines rigour, which he refers to as reflexivity, as 'the conscious and deliberate linking of the social process of engagement in the field with the technical processes of data collection and the decisions that that linking involves' (Ball, 1990, p. 159). I discuss reliability and validity in Chapter 4, but it is important to recognise the place of Ball's rigour/reflexivity within this, hence the presentation of aspects of myself here.

This thesis is about labelling, particularly ability-labelling, and the practices of this discourse in primary mathematics. Labelling and grouping practices are extensive, not just within schools but within society. As such my experiences with these are bound to influence this thesis. In understanding their influence I wrote an extended biography and have used this across the study to explore the influence my experiences have had on how I conducted the research. It allowed me to think about issues arising in the study from different perspectives: now as a researcher, but also how I may have thought about them as a teacher, giving me a deeper insight into my data.

I do not present a full biography here, but give an overview of key events which have a strong influence on this study. In doing so, I also map out the development of the thesis.

My experience with learning mathematics was far from straightforward and undoubtedly influenced where I am now, how I feel about where I am, and this study. At school I experienced the full spectrum of labelling and placements in mathematics classrooms from 'a natural gifted mathematician' to the lowest ranking in the bottom-set. Despite these differing placements mathematics was, nearly always, a subject I enjoyed. What I did not enjoy, as characterised much of my secondary education, was fighting for my right to learn mathematics. Bottom-set placement saw us given the “worst” teacher. Subsequently, very little learning occurred which, for many pupils, was of little consequence as it was made clear that we would only be entered for the foundation GCSE tier and little was expected of us.

My experience in secondary mathematics mirrored my experiences in other subjects. I confounded teachers with inconsistent attainment, yet it was my lowest attainments that were taken as a measure of what I was capable of. Whilst I was told I was unlikely to attain any GCSEs, I wanted to follow my peers into A Level study, including mathematics. Having fought to take the higher-tier mathematics GCSE paper I self-taught from the textbook and went onto study A Level mathematics. Here we were no longer set, I had new teachers, and through selecting the least popular modules had two years of intensive input. Under these conditions I did relatively well and continued to enjoy mathematics, so it was little surprise that I specialised in mathematics during my teacher training. Within the mathematics components of my degree I returned to my starting point, re-inhabiting the position of a ‘gifted mathematician’ I had been given at the age of four.

I went from teacher training straight into primary teaching. Whilst mathematics continued to feature strongly, other issues came to the fore. I felt unprepared to cope with what I, at the time, referred to as a wide range of abilities. I was uncomfortable with school grouping and setting policies. These seemed inequitable to many pupils, not least those at the extremes: pupils with SEN and pupils labelled ‘gifted and talented’. After four years I took a year out hoping to address these issues and started the MA in Mathematics Education at King’s. Seven years later, I am still searching for answers to the questions which brought me here and to others which arose in the meantime.

When considering topics for my MA dissertation, I initially wanted to explore provision for the Gifted and Talented in primary mathematics. However, it was not long into the MA that I was challenged to think about what Gifted and Talented actually meant. This led me to question much that I thought I knew and took to be ‘normal’ as a teacher. I felt cheated and that I had been led to believe in, and engage in, practices that were not only poorly evidenced but which were also potentially harming the pupils I taught. Needing to understand how I had been able to engage in ability labelling and grouping practices without questioning the underlying assumptions, I used my MA dissertation to examine the extent to which Government policy documentation impacts on teachers’ use of ability.

Feeling I now had more unanswered questions I extended this research in an MRes dissertation. This MRes study used empirical work to explore ways of finding out how ability is being understood and used in the primary mathematics classroom. The research provided a justification and focus for the present PhD study, acting as an initial pilot stage. The role of this pilot study and the subsequent development of the PhD are discussed in Chapter 4.

It is clear that my biography has had an impact on this thesis. My experiences as a teacher led me into further study, but I was not prepared for where this took me. Subsequently I have continually questioned those teaching experiences and what I see and hear talked about in education and more widely. Unsurprisingly it has led me to think about the experiences I had as a learner and to reflect on the impact of casual and diagnostic labelling applied to me and the impact of this on my educational experiences. Undoubtedly this impacts on the emotions and relationships Mendick talks about in conducting research in terms of how I felt at the time of data collection and how I came to understand the data. It has been important to reflect on this as one aspect of ensuring rigour in the study and the presentation of this biography hopefully shows the consideration given to the role of the researcher.

2.3 Critical Realism

My use of critical realism has had a lengthy history spanning the seven years of the development of this research and its place within the study has changed considerably over that time, something which is reflected in the space given to discussion of critical realism in this thesis. In the previous studies and the earlier stages of the present study, critical realism played a strong role allowing me to grapple with practices I had engaged in as a teacher alongside my developing knowledge of an ideology of ability. It gave me a focus for the research; a way of conceptualising change and working towards the much wider goal of emancipation. As I worked through the study, the place of critical realism changed; this earlier more theoretically driven impetus to use critical realism was superseded by its approach to, and acceptance of, mixed-methods research. Following the empirical stages of the research, critical realism played a role in guiding the analysis, particularly in terms of thinking about transformation, but in a more limited capacity than the initial theoretical stages, hence there being little in the latter stages of this thesis directly related to critical realism. However, the initial reasons for taking a critical realist approach and the guidance it gave me remained, even though not explicit in the writing.

My first encounter with critical realism came early in my MA dissertation. Having had everything I thought I knew to be 'true' about ability shattered, I tried to put together an understanding combining what ability might be and how it was being used in schools. In doing this and grappling with what was truth, my MA supervisor, Mike Askew, suggested a critical realist approach might fit the position I had reached. Whilst finding critical realist writings initially difficult to access, critical realism appeared useful in my study and in helping me come to terms with why I had engaged in the practices I had.

At this stage, critical realism offered a way of thinking about how research findings were used – or not – in schools. Additionally, it gave a way of conceptualising change. Critical realism allows unwanted and unneeded structures to be replaced with wanted and needed ones through a transformative process. Of course, these still have to be identified and change accepted, but critical realism can help here as it 'offers the educational researcher the opportunity to keep in mind what they should be working for, the movement towards emancipation' (Shipway, 2002, p. 279). A critical realist approach brings consciousness to oppressive structures that rely on a lack of consciousness for their oppressive effects to be reproduced (Porter, 2002). Research results under critical realist principles have the potential to be used for emancipatory action, challenging the status quo which operates in a reproductive mode to disallow alternative approaches.

Given that critical realism seemed useful within my MA study, I was keen to explore how it fitted with empirical research in my MRes study. This suggested that critical realism could be strong in dealing with the various complexities and contradictions in the literature and in my data. However, it was noted that critical realism's guidelines were limited.

As a result of the issues raised in the MRes study, I invested time early on in this PhD developing a fuller understanding of critical realism generally and in relation to my study. One aspect I found particularly helpful was that critical realism takes the self to be situated within its 'socio-historical location' (Cruickshank, 2003, p. 1), hence recognising the role of the researcher's biography, a position I found necessary as discussed previously. My early work on critical realism suggested this was a vast area, although this will not necessarily be apparent given the limited coverage in this chapter. I found that as I moved through this research, the role of critical realism moved from being at the forefront of my study towards a guiding position. Although critical realism still guided how I conducted my research and thought about my data, this became a less conscious process and less explicit in my writing. Although critical realism does not appear within the thesis as a long theoretical discussion, its strength is still present.

As a result, the following subsections are intended to provide sufficient background to understand what critical realism is and how it impacts on this study but are focussed on the practical uses and implications of a critical realist meta-theory. I begin by outlining the critical realist philosophy and what it means to be a critical realist (section 2.3.1). In exemplifying this, I look at how critical realism has been developed in Educational Studies (section 2.3.2) and the implications of such an approach for the present study (section 2.3.3).

2.3.1 A critical realist philosophy

Critical realism originates from debates over naturalism, the transfer of transcendental realism from the natural to the human sciences (Bhaskar, 1979). The term, emphasising the critique of other philosophies and beliefs, was a hybridisation of Bhaskar's critical naturalism and the debated transcendental realism (Bhaskar, 1989). Identifying oneself as a critical realist involves holding a belief in the existence of unobservable entities in the social sciences. These entities are taken as real and believed to have their own underlying structure. Through having their own structure, they have powers and stratified generative mechanisms (Bhaskar, 1975; Collier, 1998) although these may or may not be exercised or consciously realised (Archer, 1998).

The basic constructs of a realist approach are that the world exists independently of our knowledge of it, and that the knowledge we have of it is imperfect (e.g. Miles & Huberman, 1994). A Bhaskarian realist approach (e.g. Bhaskar, 1998a) extends this. As Moore (2000) argues in looking at the strengths of a realist approach to the debate on curriculum reform, a realist approach to understanding, as well as working towards emancipation, allows a reappraisal of previous distinctions in, and ways of thinking about, knowledge. Whilst realism still begins with a socially and historically constructed knowledge, it addresses the relativist tendencies which Moore (ibid., p.17) argues may occur 'when epistmology [*sic.*] and the sociology of knowledge are seen as opposed rather than complementary.' Moore goes on to suggest that such an approach is problematic in that it is an 'outmoded' (ibid., p.17) way of understanding knowledge and of little value in thinking about how schools work.

Even when taking historically constructed knowledge as a starting point, most critical realists would accept many aspects of weak social constructionism[2] (Sayer, 2000). Like social constructionism, critical realism shares the goal of exploring social knowledge and phenomena and the belief in the existence of a material world. However, critical realism goes beyond this transitive knowledge to assert that there is an intransitive real world. Given their different beliefs about the real world, critical realists and social constructionists would approach research differently: critical realists through a scientific model and social constructionists through recourse to the language used in bringing about the world. Some commentators have argued that the two positions are more similar than they are different and that further discussion is needed as to whether critical realism can justifiably critique social constructionism (Deetz, Newton, & Reed, 2007). However, the key differences in the conceptualisation of the world are important within the present study.

Critical realism engages with a reality outside of our representations (Cruickshank, 2003), using depth ontology to make claims about how the world actually is and the different levels at which reality can be experienced and understood. Critical realism shares ontological realism and epistemological relativism (fallibility) with post-modernism (see Chalmers, 1999). However it goes beyond these. Unlike postmodernism, critical realism believes that it is possible to attempt to access truth and to say that one theory is more likely to be correct than other. Labelled judgemental rationality, critical realists believe in the possibility to make these judgements between competing claims, achieved through using the judgement form as set out by Bhaskar (1993), and with claims tested for universalizability.

2.3.2 Critical realism in educational studies

Within educational research the uptake of critical realism is fairly new. The philosophy has ‘wide diversity’ across disciplines (Kowalczyk, Sayer, & New, 2000), but although it entered education almost twenty years ago with the work of David Corson (Shipway, 2002) the

[2] Social Constructionism, a school of thought within sociology, is the belief that no reality – subjective or objective – exists outside of that produced and reproduced through social interactions (Berger & Luckmann, 1966). See Marks (2005, pp.20-22) for a fuller discussion of weak and strong social constructionism and its relation to critical realism, mathematics and ability.

explicit application of critical realism to educational studies has been limited (Shipway, 2007, *Personal Communication*). Despite this limited uptake, critical realism has much to offer educational research, providing an 'educational science' (Shipway, 2002, p. 273); a way of exploring the objective reality that we are 'intimately and inextricably engaged with' (Wright, 2004, p. 54). Additionally, it offers hope for bringing about change, being an antidote to the 'recalcitrant, self-sustaining conflict' of current educational research, allowing us to move towards emancipation (Shipway, 2002, p. 274).

Critical realist principles are fairly encompassing, and many educational researchers may be thought of as working tacitly and implicitly in accordance with these (Maton & Shipway, 2007). In particular, a critical realist approach works with the ontological and epistemological assumptions that have previously resulted in an educational battleground comprised of 'two principle and entrenched positions', namely naturalistic objective approaches to social reality and hermeneutic descriptions of people's experiences and social occurrences (Maton, 2001). Critical realism is not a method in itself, but opposes 'unity of methodology' (Archer, 1998, p. 190) and allows the disconnection of powerful research methods from their traditions (Shipway, 2002). In doing so, critical realism has its own way of understanding methods and data and begins to close the chasm between quantitative extensive methods and qualitative intensive methods.

Within critical realism, correlations between variables are taken as descriptions and the effects of underlying causal properties (Cruickshank, 2003). Instead of identifying cause and effect, critical realism is concerned with potential explanations for apparent regularities (Bhaskar, 1975). A critical realist approach requires the researcher not to look at bits of a solution but instead conceptualise the whole with clues drawn from a variety of sources. In particular, critical realists would argue against the positivist misnomer that truth-claims in the social sciences have more weight if supported by quantitative rather than qualitative data (Shipway, 2002). However, this does not mean, as some commentators assert (cf. Nash, 2005; Porter, 2002), that critical realism rejects quantitative methods.

2.3.3 Critical realism and the current study

Critical realism is appealing as it gives extensive methodological possibilities and support for the position of the researcher. Further, it is useful within this study as it allows me to examine the three key ideas of this thesis – production, reproduction and transformation – under one guiding theory, and hence to be clear about how I am using these terms.

Bhaskar refers repeatedly to production and reproduction, and it is with the same understanding that I am using these terms:

> 'Society is both the ever-present condition (material cause) and the continually reproduced outcome of human agency. And praxis is both work, that is, conscious production, and (normally unconscious) reproduction of the conditions of production, that is society. One could refer to the former as the duality of structure, and the latter as the duality of praxis.' (Bhaskar, 1998b, p. 215)

Production and reproduction both bring to the fore the critical realist assumption that the world is characterized by emergence. Emergence is the generation of new beings (entities, structures, totalities, concepts) from the conjunction of two or more other beings. However, the newly produced being, although relying on them for its existence, cannot be reduced to its constituents (Bhaskar, 1998a; Sayer, 2000), and the new being goes on to develop its own causal properties (Cruickshank, 2003). Hence society, and the structures of society, are not created by human agency ('the error of voluntarism'), but neither can they exist independently of human agency ('the error of reification') (Bhaskar, 1989, p. 4). There is agentive involvement, but it is done with pre-existing structures. This gave a basis to explore how pupils and teachers produced understandings of ability and the role of existing structures in this. Critical Realists view science and the stratified nature of entities as continually in a process of reproduction. Bringing this understanding of reproduction into the study allowed exploration of how understandings of ability are communicated, taken on, shared and altered. In addition, critical realism examines oppressive structures and sees them as relying on a lack of consciousness of their oppressive effects in order to be reproduced (Porter, 2002). This allowed me to examine how oppressive structures worked against individuals.

Critical realists refer to reproduction which results in structural change as transformation. I originally conceptualised my study in terms of contestation as I wanted to understand where pupils were able to contest the ability labels given. However, early data analysis suggested that direct contestation did not happen and instead more subtle processes, coming within critical realism's understanding of transformation, were taking place. Critical realism's use of transformation is quite encompassing. It allows for negotiation and agency. Individuals are seen as actively participating in the shaping of social structures whilst at the same time being themselves transformed by them.

2.4 Discourse and Identity

This thesis makes use of a number of theoretical terms which may lead to confusion unless clearly defined. Some terms were explained within the theoretical grounding of critical realism. Other terms are used in a broader sense and I explain two of these – discourse and identity – here. I begin by outlining my position on the two separately before considering how the three perspectives: critical realism, discourse and identity, may be compatible.

2.4.1 Discourse

Discourse is used in many different ways particularly within language studies and in the use of discourse analysis. I am interested in a way of working that helps me to understand something practitioners work with day to day. Recent studies concerning discourse in mathematics education have provided a way of locating and understanding teacher and pupil interactions (Seeger, 2001). They also give a way of understanding meaning making (Barwell, 2005; Leung, 2005; Morgan, 2005), with learning mathematics variously seen as a process of interpretation of, and/or induction into, a discourse (Brown, 2001; Sfard, Forman, & Kieran, 2001). However, using multiple viewpoints adds unnecessary confusion. In addressing this, I took the work of James Paul Gee (1999, 2001, 2008) who claims his use of 'Discourse' to be broadly similar to the approaches of many other theorists. The advantage of Gee's approach is that, in being eclectic, it is open to different and competing approaches and insights (see, for example, Kidd, 2004, for the use of this eclectic approach).

Discourse, according to Gee (1999, 2008) is both a way of sense-making and fitting and creating contexts and situations. Sense-making is embedded within a wider social framework. Gee counts discourse as 'any stretch of language (spoken, written, signed) which "hangs together" to make sense to some community of people who use that language' (Gee, 2008, p. 103). Gee sees the process as cyclical, where 'the structure of society simultaneously shapes and is shaped by language' (ibid., p. 103). By being part of sense making, discourses are trying to deal with things that may be complex, paradoxical or contradictory. As we try to make sense we may be simultaneously involved in a process of reproducing the social structure of which the discourse is a part. As such, discourse could be thought of as an apprenticeship into the normal social practices and beliefs of a particular community. Such apprenticeship involves inheriting ways of being and ways of making sense, with the apprentice then becoming a carrier of the discourse.

2.4.2 Identity

As with discourse, identity is used in multiple ways and brings with it many theoretical backgrounds. Initially I explored perspectives on identity situated within the two main philosophical approaches: Cartesian (a stable core self) and reductionist (psychological/memory connections). I also examined the possibility of taking a position in-between or encompassing both positions. In exploring this, I found Moore's (2006) work useful in that he recognises the complexity of there being multiple different positions and suggests combining useful approaches.

During the first year of this PhD I participated in a seminar series: *Mathematical Relationships: Identities and Participation*. Here I had the opportunity to extend the exploration of multiple positions on identity. Following the seminar series, I was invited to contribute towards a chapter in a book based on the seminar series. In doing so I needed to extract from the multiple theorists an understanding of identity for myself; this brought in the key theorists in my study. That conception of identity and the theorists drawn on is discussed in Hodgen & Marks (2009). The same approach has been used across my PhD.

The approach is broadly sociocultural, seeing learning as a process of identity development through participation and enculturation (Kirshner, 2002). In doing so the conception used draws heavily on the idea of identity within communities of practice (Boaler & Greeno, 2000; Wenger, 1998). This also brings in Carr's (2001) work on multiple, nested, and at times, contradictory, identities. Here, pupils are suggested to move effortlessly between identities with these being 'transacted, redefined and resisted' (ibid., p. 527) but in doing so they build familiar 'templates in the environment' (ibid., p. 536) guiding participation. Within this understanding, identities within communities of practice are taken as positional. This is extended further through adding Holland et al.'s (Holland, Skinner, Lachicotte Jr, & Cain, 1998) conception of figured worlds. This approach, coming from an anthropological adaptation of Mead's social psychological perspective, gives a way of thinking about identity formation and their location in multiple milieus. Holland et al. go on to discuss how identities may be changed through their notion of improvisation and the creation of new meanings. An example of such a contradictory identity related to this study may be the pupil who finds themselves in a top-set – giving a grounded positional identity – but who enacts a figured identity of being 'bad at maths'.

Gee's position on discourse and the position on identity outlined above are key theoretical perspectives in this thesis. These are compatible, with Gee's (1999) work being brought into the discussion of identity in Hodgen & Marks (2009). Whilst one is predominantly sociocultural and the other discursive, there are similarities between the two. For instance, Wenger's (1998) understanding of knowledge as located within a regime of competence has resonances with Gee's knowledge/language in context. The positions allow for identity to be conceptualised as a relatively stable core embedded within a more fluid identity. Additionally they allow the exploration of the role of language in how sense is made of particular situations and how, subsequently, these senses may have been improvised or reconstructed or individuals may have been pushed by powerful discourses into different identities (Holland, et al., 1998).

2.4.3 Discourse, identity and critical realism

Exploring notions of identity fits within a critical realist perspective. Critical realists see individual human identities as making up part of a greater identity. In such a way, humans are seen as part of the ontology of the natural order, being simultaneously a part of, and engaged with, reality (Wright, 2007). One area of contention may be when identity is seen as drawing on social constructionist underpinnings. However, in relation to this thesis this can be ameliorated from two approaches. I do not take a strongly social constructionist approach to identity and I have previously suggested that critical realism and social constructionism may be compatible, to an extent, suggesting it possible for critical realism to still make use of such an approach.

The fit between critical realism and my use of discourse is clearer. Critical realism, in opposition to postmodernism, strives to understand the truth claims of text and speech, insisting upon the reality of such discourses (Bhaskar, 1989). This insistence on reality fits the understanding of discourses of ability within this study (discussed in Chapter 3). On a theoretical level, critical realism and discourse converge in critiquing empiricism and in referring to a transcendental realism (Laclau & Bhaskar, 1998). However, it should be noted that with both identity and discourse previous work on the compatibility of the positions is limited. A key argument of critical realism is the possibility of being able to separate methods from their theoretical underpinnings. Whilst identity and discourse are not research methods, they are ways in which I am conceptualising my data. I suggest that similar theoretical separation should be possible here, allowing a focus on the positive aspects each brings, without this being over-shadowed by arguments of theoretical incompatibility.

Within section 2.3.3 I looked at the compatibility between the key terms in this thesis – production, reproduction and transformation – and a critical realist meta-theory. Bringing in identity and discourse it is sensible to look again at these to ensure the compatibility remains. Production and reproduction were both noted as central concepts in critical realism. Although the same language is not used, the processes occurring in communities of practice can be seen as identity development, especially on entering new communities, or identity reproduction, where a community stabilises the identity. The concept of transformation in critical realism looks at how individuals or groups work with or against oppressive structures and how these structures change. It also considers occasions where actions may occur to ensure transformative-reproduction, i.e. a state where change has occurred to keep the outcome stable. Transforming structures and responses to them closely aligns with Holland et al.'s (1998) notion of improvisation whereby individuals have the space to change and alter practices and to re-write or develop their figured identities. Given these elements it can be argued that the various positions I take are not only compatible, but strengthen each other.

This chapter has set out how the research was developed and the theoretical positions I have taken. It has argued that these positions – critical realism, discourse and identity – compliment and strengthen each other and are appropriate for the study. In the following chapter, the literature review, I explain how ability is used and, as with critical realism, how I developed this understanding over a substantial time-period.

3 Ability: Ideology, Definition and Practice

3.1 Introduction

Homogeneous grouping, particularly setting, is a dominant practice in UK education and the subject of many reviews. However, there is more to the discourse of ability. Even without homogeneous grouping it is likely that ability would continue to work in far reaching ways. This study is concerned with deepening our understanding of what ability means within primary mathematics and how different manifestations of this are enacted. In this chapter I explore the research evidence to justify the research questions.

Ability has a vast literature. Many substantial reviews have been undertaken and adding another would do little to take our knowledge forward. Instead, I use these reviews alongside the wider literature to present the current state of knowledge. I begin this chapter by looking at the development, meaning and application of discourses of ability. This discussion provides a basis for considering ability's reproductive role in school practices. In the final section I bring the discussion together, justifying the current study.

Given the vastness of the literature, it has been necessary to take a pragmatic approach to its inclusion. An initial BEI/ERIC search produced 75000+ sources which were reduced to 1000+ and then systematically included/excluded within various sections of this review. This is not a systematic review in relation to the usual connotations of this term, but the literature has been approached and used in a systematic manner, the intention being to ensure rigour in this review. The methods used would detract from the review and are therefore set out in Appendix A.

3.2 Discourses of ability

In the previous chapter I set out my approach to discourse. Here I extend this, looking specifically at discourses of ability. I examine the development of the discourse and its different meanings. I also set out my position on ability in order to make my perspective and approach clear.

3.2.1 Ability as ideology

Ability is a powerful ideology in the UK. It is seen as a fixed, hereditary quality, characterised by upper limits, with these understandings being a dominant belief across UK society and social institutions, not least within our schooling system (Dowling, 1998; Hodgen, 2007). Government policy decisions have been based on these ideological principles rather than being grounded in educational ones (Hallam, 2002). Ability is the foundation of the majority of forms of UK classroom organisation; whilst setting is an obvious example, mixed-ability grouping also relies on a notion of ability to underscore the 'mixing'.

The historical nature of an ability ideology and its resultant practices is long and complex. The UK practice of ability-grouping was established through the 1944 Butler Education Act and remained unchallenged until comprehensivisation and research suggesting negative social consequences of grouping (Barker Lunn, 1970; Jackson, 1964). From here on mixed-ability teaching took precedence, but the ideology of ability was never lost. Streaming still exists between schools (i.e. grammar schools) and through the 1990s and into the 21st century, Government drives to improve standards have brought other forms of ability-grouping to the fore (Hallam, 2002). With growing pressure to use ability-grouping from successive Governments (e.g. Gove, 2007), the use of ability-grouping has increased across the UK (e.g. Hamilton & O'Hara, 2011; Ipsos MORI, 2010), with the most recent research suggesting that setting and streaming are more common in UK primary schools than previously thought (Hallam, 2011). Further afield, including in the US (Kulik, 2004) and Australia (Forgasz, 2010), ability-grouping is also increasing, although in all cases, as Kulik notes for the US, statistics are scarce and the full extent of ability-grouping is not clear.

One of the difficulties with ability is that it seems to function as a whole, with one characteristic of the person standing for all that they are. Ability becomes a term of multiple meanings without any solid definition. It is, Howe (1996, p. 40) suggests, 'plagued by conceptual problems', simultaneously used as a descriptor, describing what a person can do, and as an explanation for why someone can do something. Despite this its use goes unquestioned in everyday practice.

What ability actually 'is' remains unanswered. Many teachers subscribe to the dominant view, having an unquestioning stance towards the measure of this construct, with an accompanying belief that through various tests we can accurately determine a pupil's fixed level of ability and hence predict their future success. However, research (Sternberg, 1998) suggests that such tests are not measuring ability per se but are measuring an individual's current level of attainment. Using such tests to predict success and allocate pupils to groups is wrought with validity concerns, poorly understood by schools, and does not take into account the place of social factors in such predictions.

In the sense of Gee's understanding of discourse, ideologies, such as ability, are shared theories on how goods should be distributed in society, carried throughout, and forming history, through discourse (Gee, 1999). However, without consensus on the shared theory of ability, much of the literature appears to avoid explicit definition. Recent reviews highlight the methodological problems in conducting ability and ability-grouping research (e.g. Hallam, 2002; Harlen & Malcolm, 1999; Ireson & Hallam, 2003), although discussion of the central theme as potentially problematic is often more limited. It is perhaps then less surprising that this lack of questioning is reflected in practice, with 'arbitrary' (Hallam & Toutounji, 1996, p. 17), undocumented allocation (Ofsted, 1998) and a lack of specific teacher training (Norris & Aleixo, 2003). Even where limited attempts are made to engage with this concept and question fixed notions of ability (e.g. Hart, 1998; Hart, Dixon, Drummond, & McIntyre, 2004; Ruthven, 1987), the remnants remain problematic. To propose that pupils have been 'misplaced' (Davies, et al., 2003, p. 46; Macintyre & Ireson, 2002) perpetuates a discourse of fixed-ability.

Despite this unknown, ability beliefs are frequently elevated to the status of truths. This elevation becomes a defence reproducible through its 'appeals to a basic human need to stratify society' (Kulik & Kulik, 1982b, p. 619), and its apparent 'simple, rational response' to a long tail of underachievement (Ireson & Hallam, 2001, p. 1). Teachers are provided with a simple explanation for pupils' successes and failures, where it is seen as defensible to classify pupils and subject them to 'ability stereotyping' (Ruthven, 1987). 'The very fact that people today have so little hesitation about ranking individuals as being more or less intelligent is a reflection of the way the spread of intelligence testing has affected our everyday thinking about people and their capabilities' (Howe, 1997, p. 2). Underlying this lack of questioning is the fact that these are very simple messages. They seem easy to understand and appear to fit with what we 'see'. Galtonian accounts of general intelligence have, White (2006) argues, so influenced common understandings that they are not questioned because we no longer have the capacity to see them in any way as peculiar. The understanding that practitioners work with is built upon an ideology arising from a historically embedded conviction in intelligence theory and psychometric testing (Howe, 1997; White, 2005).

Ability is a difficult term because of its multiple uses. Whilst it is generally used in reference to an individual's current performance, psychologists use the term, particularly with adults, as a more stable and time-invariant concept (Ferguson, 1954). Blame has been placed on the Government for the conflation of ability with attainment (Hart, 1998), yet this conflation is pervasive. Experimental studies take out prior achievement in an attempt to control for ability (Gamoran & Berends, 1987), reviews suggest ability-grouping implies grouping by achievement (Slavin, 1987), and recent research suggests that teacher judgement works against prior academic achievement informing ability-grouping (Hallam, 2002). Yet this conflation is not consistent. Kwok & Lytton (1996) for instance, measure concepts of ability and achievement as separate variables, whilst Ireson & Hallam (2001) highlight the difficulties schools face in distinguishing between grouping by performance or attainment and grouping by ability.

The existence of multiple meanings is not new (Slavin, 1987). Esposito (1973) uses ability, standardized reading, IQ, standardized intelligence, aptitude and achievement to refer to the same undefined concept. 'While ability could simply be an alternative for "achievement" or "attainment", the reality is that it shares the assumptions of intelligence testing: that ability is seen as *the cause of achievement, rather than a form of it*' (Stobart, 2008, p. 31, original emphasis). The assumption has been, and often appears to remain, that this is unproblematic. Alongside multiple meanings, the reference to a singular general, or overall, ability, particularly in discussing streaming, is not uncommon (e.g. Harlen & Malcolm, 1999; Ireson & Hallam, 2001; Kutnick et al., 2005; Norris & Aleixo, 2003). Slavin talks about ability-grouping reducing 'IQ heterogeneity' (Slavin, 1987, p. 305) and about 'composite achievement and IQ' informing group assignment (Slavin, 1990, p. 472), whilst Harlen & Malcolm (1999) refer to ability-grouping as producing low, average and high-IQ pupil-groups. Such conflations are then confused further through the imposition of teacher judgements, often based on behavioural factors (Ireson & Hallam, 2001).

Socially held beliefs, particularly around a fixed conception of ability, have their origins in intelligence theory and psychometrics. This is evident in the use of IQ/cognitive ability tests in schools to group, and to predict the future attainment of, pupils (Hart, 1998). The psychometric movement may have died down, but its legacy dominates 'test research' (Bishop, 1976, p. 31) and the 'folklore of the classroom' (Wheeler, 2001, p. 5). Further, theories of intelligence and the legacy of the psychometric movement still dominate popular culture in the UK, naturalising a discourse of intelligence, and adding strength to the use of such beliefs in educational settings. White (2005, 2006) suggests that ability is a powerful principle in the UK because notions of hereditary intelligence and innate inequality (e.g. Galton, 1869/1978) reflect the Platonic natural born differences and classes of man, with intelligence testing having puritan roots. Theories arising out of the psychometric movement have influenced shifts in ability-grouping, with the advent of psychometric testing supporting the development of concepts such as intellectual limitation and capacity measurement (Ireson & Hallam, 2001). The idea that pupils come 'hard-wired' with subject abilities is an appealing idea to teachers (White, 2006, p. 140). Such concepts legitimised, and made logical, educational stratification, a legitimisation which has continued to underlie selection.

Ideological positions stem from a Galtonian (1869/1978) innateness and pre-determined destiny view of ability. Whilst our knowledge has moved on, this concept of ability remains 'remarkably salient' (Hart, 1998, p. 161) because we do not have evidence to say that assumptions of ability are 'incontrovertibly outmoded' (ibid., 1998, p. 155). Recent research suggests that ability is a more complex notion than previously conceptualised, involving the interaction of multiple genes and an individual's global behaviour (Hallam, 2002) with the environment and learning in the development of a dynamic intelligence (Hallam & Toutounji, 1996). The recently completed US Human Genome Project (1990-2003) identifying the 20,000–25,000 genes and determining the sequences of the three billion chemical base pairs in human DNA, has brought mixed outcomes in the search for 'genes for intelligence'; some strengthen an innateness argument though a folk psychology understanding of genetics whilst others challenge long held beliefs. Current research suggests that just over a third, approximately 36 per cent, of school achievement difference can be 'explained' by some generalist notion of IQ (Hallam, 2002; Hallam & Toutounji, 1996; Oliver et al., 2004; Plomin, Kovas, & Haworth, 2007). Studies with different methodologies suggest various degrees of heritability, yet the key point they agree on is that mathematical-ability is not all genetic; 'raw achievement shows moderate heritability' (Haworth, Asbury, Dale, & Plomin, 2011, p. 1) and does not imply limited 'malleability' of achievement (Kovas, Harlaar, Petrill, & Plomin, 2005, p. 486). Results are not consistent, with heritability estimates found to vary non-linearly with socioeconomic status, with very limited heritability of achievement in the lowest socioeconomic environments (Tucker-Drob, Rhemtulla, Harden, Turkheimer, & Fask, 2011; Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003).

Overall, IQ is a 'relatively small part' of success (Hallam, 2002, p. 4) and other factors are more important in determining learning outcomes. Kovas et al. (2005) propose that environmental differences are crucial to differences in performance across domains. Given this, the justification of ability-grouping, based on an historical interpretation of intelligence theory, is problematic (Hallam & Toutounji, 1996). Selection is further problematised because the tests at its core were never guided in their construction by a definition of what they were measuring: intelligence and ability (Howe, 1997). 'In the psychometric tradition, the dominant view was that intelligence is largely fixed and impervious to environmental influence' (Adey, Csapó, Demetriou, Hautamäki, & Shayer, 2007, p. 81). Hence, these tests that were seen as insufficiently reliable and lacking validity 35 years ago (Esposito, 1973), are used in much the same way today (Hodgen, 2007). Despite growing scientific awareness, ideology persists, with Plomin et al. (2007) finding that more than 90% of teachers and parents believe genetic influences on ability to be more than or at least as important as environmental ones. Where our understanding seems to fall apart is not in understanding whether intelligence is innate or the proportions of environmental/genetic influence but in understanding why education continues to embrace an innateness ideology and how ability continues to be used as an explanatory term.

3.2.2 A position on ability

Ability is complex. However, in a thesis with this at its core, it is important to understand the researcher's position. As stated in Chapter 1, this thesis has its foundations in previous studies and as such, several years' work in which the core concepts have been explored. Within the early stages of this present research, drawing on literature from the previous studies, I developed a working definition of ability. This enabled me to state my approach and guard against the potential criticism that my work took an issue as problematic yet made no attempt to address this. It is important to note at this point that although I have sought to define ability in order to clarify my position, the central concern of this thesis is with how ability is understood and experienced by those encountering it on a daily basis within schools and how an ideology of ability comes to have the impacts it does.

My original working definition was intentionally open, allowing me, within the framing of critical realism, to elide aspects of the genetic and environmental debate with an understanding of ability as a powerful ideology. It involved seeing ability as consisting of two components: one semi-fluid and one fluid. This basic model closely resembled Demetriou's model of central and specialised cognitive processors (Adey, et al., 2007) as shown in Figure 3, although the working definition went beyond this to include the complex interplay between the components and the role of belief-systems in their enactment.

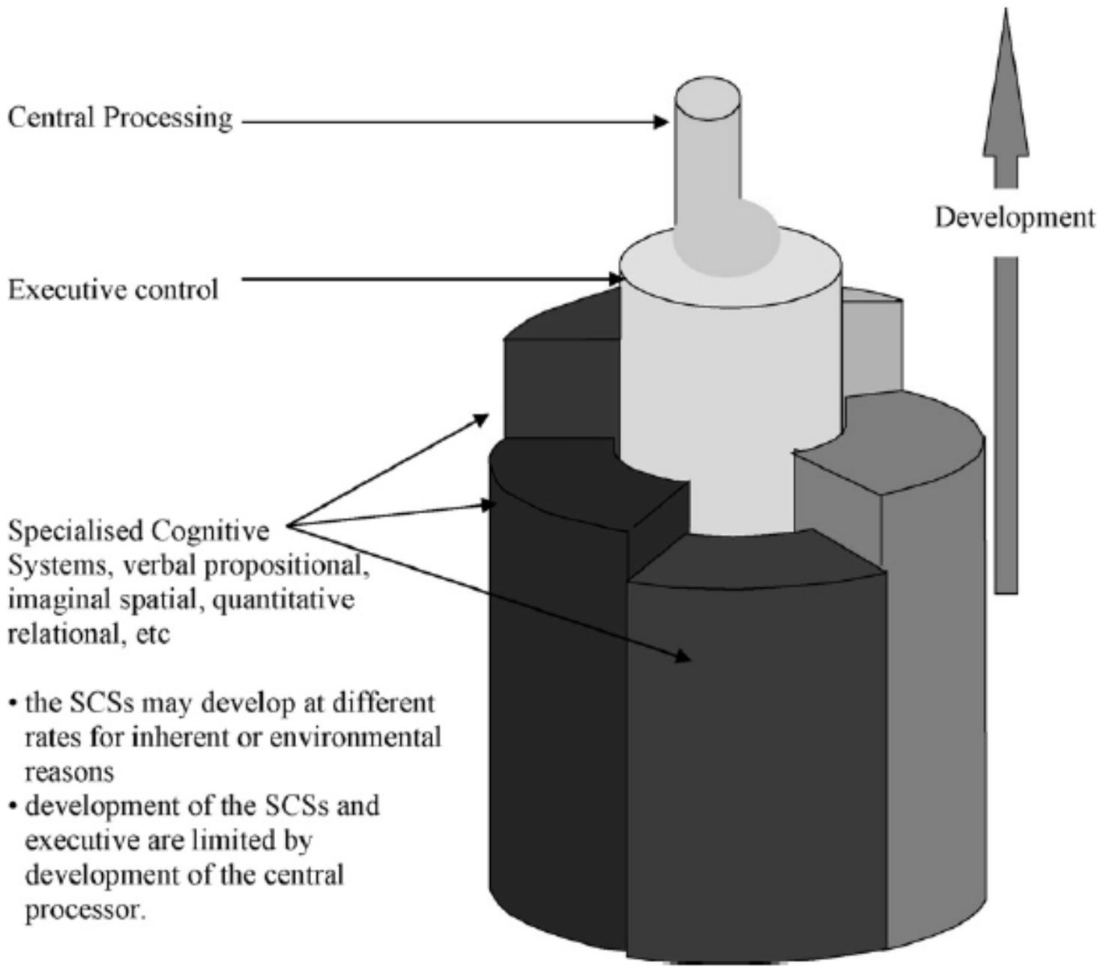


Figure 3: Demetriou's model of central and specialised cognitive processors **(Adey, et al., 2007, p. 84)**

This working definition served as a useful grounding, enabling me to conduct the study whilst developing my position on ability. Whilst I was keen to emphasis the semi-fluid component as carrying no notion of direct determinism – hence detracting from Demetriou's central processing limitations – the original working definition was heavily influenced by the scientific literature and there being a set ratio existing between individuals' semi-fluid and fluid abilities. Very recent literature suggesting the non-linear variability of heritability with socioeconomic status and the dynamic interaction between genetic and environmental factors (Shenk, 2010), alongside early findings from the present study, led me to question the core component within my definition. Whilst the original model still stands, the components, and the genetic and environmental influences on outcomes, are complexly and dynamically interwoven. Genetic involvement is as an influence rather than a determinate, and no outcome is pre-set to a given quantity. Environmental impacts are strong, dynamic, and complex, occurring in ways that are recognised and unseen.

My position is quite removed from that taken by many practitioners. A critical realist perspective allows me to retain this understanding whilst exploring the concept from the very different perspective of teachers working with an ideology of ability. Thus far, I have looked fairly generally at ability. However, a special case is often made for mathematics in respect to intelligence, and in the following section I explore further whether this is justified and what this might mean for a study looking into ability in mathematics classrooms.

3.2.3 Mathematics as a special case

Mathematics and mathematicians are often considered in popular culture as different or special (Bartholomew, 2002; Mendick & Moreau, 2007; Moreau, Mendick, & Epstein, 2007). In this section I look at whether mathematics is a special case and the various discussions around this. In particular I set up some background for a later discussion of ability practices in mathematics and the underlying justifications for these.

Within the ability literature there is some suggestion that the impact of setting is different in mathematics compared with other disciplines (Ireson, Hallam, Hack, Clark, & Plewis, 2002), but often mathematics is focused on for reasons of greater research funding and the perceived role of mathematics as a tool for other areas. Studies tell us little of how mathematics is different from other disciplines carrying similar notions of innateness, giftedness and talent, for instance, languages and physical education. However, there seems to be something in how mathematics is conceptualised as special and segued with notions of intelligence in popular discourse. Innateness conceptions seem stronger in mathematics with many implicitly suggesting that there is an entity that can be labelled mathematical-ability (e.g. Torbeyns, Verschaffel, & Ghesquiere, 2004) and explicitly suggesting some individuals to have a particular 'cast of mind' for mathematics (Bishop, 1976, p. 33).

Mathematics carries a particular subculture or 'microcosm' with its own values and traditions (Goodson & Managan, 1995), yet this does not make mathematics unique, for each discipline is a major structural and reference point in the secondary school (Goodson, 1993). More unique is that mathematics carries a complex history (Goodson & Marsh, 1996) where arguments over what it is, what counts as mathematics and what mathematics should be taught, result in distinct subject sub-cultures (Cooper, 1984). Teachers bring a specific culture into their teaching (Bennett, Carré, & Dunne, 1993) reproducing the societal image of what mathematics is. Given this reproduction, it is unsurprising that the widely perceived view of mathematics as difficult and hierarchical is reinforced through the differential subject practices of the subject culture (Baines, Blatchford, & Kutnick, 2003; Bartholomew, 2002) with the result that mathematics is reproduced 'as an ordered progression through a hierarchy of knowledge and skill, mediated by a stable cognitive capability of the individual pupil' (Ruthven, 1987, p. 247).

Whilst there seems to be a culture specific to mathematics, it is unclear of the extent to which this accounts for the segueing of mathematics and intelligence in popular discourse. Recent neurocognitive research takes us in two directions at once. On the one hand we have Kovas et al. (2005, p. 474) telling us that research on mathematical-ability is limited and poorly understood, although 'mathematics performance covaries phenotypically with reading and with g' and the more innate aspect of intelligence/ability seems to arise from generalist genes; that is the same genes are responsible for language and mathematical-abilities (Kovas, et al., 2005; Plomin & Kovas, 2005; Plomin, et al., 2007). On the other hand we have ongoing research which seems to converge more with public discourse suggesting the possibility of an inherited capacity for mathematics encoded in the genome (Butterworth, 1999) or a brain-structure predisposing individuals to mathematical-ability (Baron-Cohen, Wheelwright, Burtenshaw, & Hobson, 2007; Revill, 2005). Alongside this, Krutetskii's (1976) older Soviet-psychology rejection of innateness in favour of experiential development which contains some acceptance of inequality through referring to pupils with mathematical talent, is still referred to, particularly in mathematics education.

The origins of a link between mathematics and intelligence possibly lie in the need for test items in the earliest intelligence tests to be unaffected by cultural initiation (White, 2006). The most abstract forms were thought to be logical and mathematical, hence mathematical items have figured heavily in intelligence tests from their inception. Most people will be familiar with intelligence test items so the possibility exists of these producing a segueing of mathematics with intelligence. With a dominant discourse suggesting mathematics as special, we should examine what this means for schools. In the following section I look at the implication of an ability ideology for educational practices. What seems to happen is that a discourse of ability sets mathematics up as a difficult subject that people either can or cannot do (Bartholomew, 2002) where memory is prioritised over thought (Boaler, 2000b) and where we have an innate, pre-determined limit constricting how far we can go (Brown, Brown, & Bibby, 2008). Such a discourse allows the segregation of society into a larger 'cannot do' opposing the minority 'can do'; a segregation that is essential in understanding successes and failures within the subject.

3.3 School Practices and Discourses of Mathematical-Ability

Whilst we talk about ability as something on its own, it holds what appear to be two contradictory positions. It is used simultaneously as something that sits within educational discourses and as something which subsumes or elides other discourses (Muijs & Dunne, 2010). Whilst bearing in mind that ability may be part of something bigger, it is the literature drawn in when considering ability as an elision of other educational (and sometimes non-educational) discourses that I consider here. Dowling (1998, p. 50) notes that 'although students differ one from another in objective terms, the curriculum does work in order to recontextualize these essentially non-educational differences as differences in educational attributes and performances'. Ability appears to be used as a way of bringing together such 'educational attributes and performances', but, perhaps as a result of such reification, the practices arising from a dominant discourse of ability are not limited to ability-grouping. Ability would exist independently of the practices it predicates. Reification makes it necessary to consider literature beyond the scientific literature to understand how ability is conceptualised and experienced in primary school mathematics.

In this section I examine this broader literature looking at how an ideology of ability, alongside other educational attributes, is produced and experienced. In doing so, I look particularly at the literature on attitude and assessment with respect to ability as examples of the subsuming nature of an ideology, and use of, ability.

3.3.1 Beyond ability-grouping: Ability discourses in practice

Mendick (2006) attests that mathematical-ability, as an innate quality possessed by individuals, is irrelevant to understanding success and failure within the subject. However, the picture may be more complex. Ability as a subsuming quality of the pupil created alongside their successes (and/or failures) is relevant and innate ability discourses surround achievement. Such discourses may not represent reality but this discourse underpins much of what happens in mathematics teaching and learning. As such, it cannot be ignored because it is thought of as relevant by wider society. Boaler's (2000b) work is useful here in that she argues for knowing and doing to be inseparable; what is learnt is learnt through the practices that surround it. In the case of mathematics, these practices are heavily caught up in a dominant discourse perpetuating innateness. Conceptual differences, the way society thinks about 'people who do', has an essential role to play in the sub-culture that is mathematics.

It is important to note that practices are not just those that appear to be explicitly about ability (i.e. ability-grouping). Ability is such a pervasive, and in a particular sense, useful, discourse, that, as Dowling (1998) suggests, schooling allows other differences to be recontextualized as ability differences. Such recontextualization results in a perceived need to tailor the curriculum to specific levels of mathematical-ability (Livne, Livne, & Milgram, 1999), yet whilst pupils and teachers may then make statements about mathematical-ability they are likely to be drawing on other discourses which in turn all become part of what ability 'is'.

There appears to be something particular about mathematics as, over time, it has remained consistent in its use of selection practices (Boaler, et al., 2000) persisting even through the 'ascendancy' of mixed-ability teaching (Boaler, 1997c; Ruthven, 1987). Ability practices vary between, as well as across, subjects (Baines, et al., 2003), but are far more common in mathematics (Ireson, Hallam, & Hurley, 2005). Within primary schools, 56% of reception classes are taught in within-class ability-groups, rising to 72% by year 2. The drop to 41% of year 6 classes being organised into within-class ability-groups reflects a surge in the use of setting in the upper primary years, with 39% of year 6 pupils set for mathematics (Hallam, Ireson, Lister, Chaudhury, & Davies, 2003).[3] When compared with English/Literacy, the pattern of practices (shifting from within to between-class ability-grouping) is similar but the percentage of schools implementing such practices is far smaller with 17% using same-age setting for English in the upper primary years. This move towards increased setting in upper primary is reflective of secondary school practices. Whilst many secondary schools initially use mixed-ability teaching in mathematics in Year 7, Boaler suggests it to be fairly typical for teachers beyond year 8 to have no experience of mixed-ability teaching, and setting is almost universal in the upper secondary years. Further, the purported 'uniqueness' of alternative methods to homogeneous grouping such as Boaler's (2008) 'relational equity'[4] approach built on Complex Instruction (Lotan, 1997)[5], suggest how pervasive ability-based groupings are in mathematics.

Unsurprisingly, given such an extensive uptake of setting, the greatest use of internal testing in allocating pupils to groups is found in mathematics (McPake, Harlen, Powney, & Davidson, 1999). Teachers take an unproblematic, uncritical stance to what such tests can tell them, accepting the results as a valid measure of individual students' ability and hence a reliable determinant of group placement. This goes someway to explain the considerable group-misplacement found by Macintyre and Ireson (2002), reflecting, through teachers' uncritical belief in their groupings, the central position that ability plays in mathematics teaching and the assumption of a wide variation in students' innate abilities (McPake, et al., 1999; Ruthven, 1987).

---

[3] A similar shift from heterogeneous to homogeneous grouping was found in America, where across 720 schools, between-class groupings rose from 2% in Kindergarten to 53% by 6th Grade (Mason, 1995).

[4] Relational Equity draws on the Complex Instruction approach, referring to the characteristics of the approach taken by students in a Complex Instruction class – namely respect and responsibility (Boaler, 2008). This is argued to result in classrooms where students respect each other's differences and listen to the opinions of others, in a commitment to the learning of all participants.

[5] Complex Instruction is an approach built on 30 years of research and development stemming from sociological analysis of various classroom features. As a pedagogical approach, it takes a multiple ability perspective, requiring all pupils to work on highly challenging tasks leading to academic achievement. Challenging traditional status differences in groups, it predominantly takes on an organisational model where each group member has a role to play in and is responsible for the success of the group and equal participation is required.

The effect of ability discourses will be discussed further in section 3.4. However, it should be remembered that ideas of ability and hierarchy are central to theorisations of learning and teaching (Ruthven, 1987). If other differences and attributes are being reconceptualised as ability differences, this clearly has implications for the teaching and learning offered to different groups, and the resultant outcomes for learners. In the same way that dominant ideological positions are connected to subject cultures and subject cultures to subject practices, so too are each of these to the specific outcomes seen in, and attitudes towards, mathematics learning.

3.3.2 Attitudes and ability judgements

Attitudes of pupils and peers, teachers and parents, have a key role in ability judgements. It seems intuitive that 'affect plays a significant role in mathematics learning and instruction' (McLeod, 1992, p. 575), yet within the context of mathematics education, attitude is a complex concept embedded in an equivocal literature. Attitudes towards the subject and across 'abilities' appears inconsistent. Although statistically significant differences are seen between the attitudes towards mathematics (Hallam & Deathe, 2002) and mathematical self-concept of pupils in high- and low-groups (Macintyre & Ireson, 2002), group placement seems to have an inconsistent effect on attitudes. These attitudes may be mediated by additional factors such as general self-concept (Hallam & Deathe, 2002), an individual's position within a group and teacher quality (Haladyna, Shaughnessy, & Shaughnessy, 1983; Middleton & Spanias, 1999). Further, recent analysis (Ruthven, 2011) suggests that attitudes towards mathematics have declined for all pupils, possibly in relation to the development of national strategies.

In my methodology chapter I touch on the difficulties inherent in attitudinal research. It is important to consider a rigorous approach here in light of our lack of understanding within mathematics of the 'interrelationship between affect and cognition' (Zan, Brown, Evans, & Hannula, 2006, p. 117) (see also Ma and Kishor's meta-analysis (1997), reported in Philipp, 2007) and the suggestion that such variables 'interact with each other in complex and unpredictable ways' (McLeod, 1992, p. 582). However, despite such complexity, some sense needs to be made if we are to take our knowledge forward. In this section I look at the attitudinal literature within mathematics education, reporting what we currently know about students' attitudes in mathematics education and considering how this may be implicated in judgements of ability.

Research into attitude in mathematics education is complex, having been plagued over a substantial time by accusations of limited theoretical foundations (Haladyna, et al., 1983; McLeod, 1992). Part of the difficulty seems to be that the terminology is broad and differently defined by different commentators. Haladyna, Shaughnessy and Shaughnessy (1983) for instance, would not include self-perception of mathematical ability in attitude towards mathematics, yet Middleton and Spanias (1999) would see this as central. Within this thesis, I take McLeod's definition that 'attitude refers to affective responses that involve positive or negative feelings of moderate intensity and reasonable stability' (1992, p. 581). Although recent work has sought to redress these issues (see for example the 2006 special edition of ESM devoted almost exclusively to different theoretical approaches to attitude) such literature still picks up on the difficulties presented by a lack of a suitable framework with which to study attitudes in mathematics learning (Op't Eynde, De Corte, & Verschaffel, 2006), particularly in terms of linking cognitive and affective factors in mathematics education (Philipp, 2007). Whilst the limited consistencies in the research are of interest in that they 'represent the current boundaries of our knowledge' (Middleton & Spanias, 1999, p. 79), current research efforts are concerned with developing better theoretical frameworks and methodological instruments in order to understand further what is going on.

Earlier attitudinal studies in mathematics education have been criticised for taking the individual absent of their social context as their unit of analysis (Haladyna, et al., 1983). In many ways, this has been retained; researchers attest that little is known about the role of the social context in pupils' attitudes and motivations (Middleton & Spanias, 1999), although these appear to form concurrently with an awareness of one's own self-confidence in mathematics (Malmivuori, 2006). It is clearer from the literature that pupils' perceptions of the causes of, and experiences of, success in mathematics are important in their attitudes towards the subject. However, this success needs to be judged on the students' criteria of success; simplifying the task to artificially raise success levels would not improve attitudes (and may have the opposite effect) (Middleton & Spanias, 1999).

Given this apparent link, we need to be concerned with the beliefs we lead pupils to develop through our practices; if pupils feel unable to fulfil these beliefs, their attitudes may suffer. In particular, Middleton and Spanias note the value currently put on speed and correctness and the attitudes and beliefs this instils about what makes someone successful. This may account for Malmivuori's (2006) finding that low self-esteem (in mathematics) correlated strongly with maths anxiety on two separate measures (r = 0.57 and r = 0.49). Pupils unable to or anxious about fulfilling the communicated success criteria develop low self-esteem and a negative attitude towards mathematics. This parallels Boaler (1997a) and Wiliam and Bartholomew's (2004) work which suggested a strong reference to such practices in pupils' constructions of what mathematics is, and suggests an area warranting further attention. This is important given that attitudinal development and the communication of success is unlikely to be limited to the mathematics classroom, but to draw on and be influenced by pupils' multiple social identities.

Alongside differences across groups, Middleton and Spanias (1999) have suggested that motivational attitudes may develop early then be consolidated over time. This, they argue, predicts which students take which mathematics courses and what their level of mathematical achievement will be. Through different conceptualisations, attitudes towards mathematics are seen as persistent and lingering (Philipp, 2007) and yet open to being affected though instructional changes (Middleton & Spanias, 1999). The complex and unpredictable ways in which variables interrelate must be considered when looking at this as part of an ability discourse particularly as attitude seems to underscore much of the 'professional judgement' employed by teachers.

3.3.3 Professional judgement: Using and extending assessment data

The professional judgement employed in evaluating pupils' ability is caught up in the assumed validity of assessments. This is potentially extenuated by Government support for summative assessment (e.g. Bew, 2011). Whilst assessment is not the whole story of ability, it is pervasive in ability-labelling. Across subjects, not least mathematics, assessment, unlike attitude, does not hold multiple definitions. To the majority of teachers, 'assessment is synonymous with testing' (Hall, Collins, Benjamin, Nind, & Sheehy, 2004, p. 804). Teachers do use assessment to support learning, but this is not viewed as assessment; assessment is most often viewed as a formal process (Wiliam, 2007). Whilst, as Newton (2007) elucidates, assessment has many purposes, teachers have a tendency to focus on external accountability.

Understanding, for many teachers, relates not to mathematical concepts but to observable behaviours (Mousley, 1998). Such a formal view of assessment seems to be integrated into primary pupils' conceptions, with assessment regimes, narrowed to testing, defining everything about schooling and about pupils themselves, not least what counts as ability and where they stand in the pecking-order (Hall, et al., 2004). It is of particular concern to this study that segueing of assessment with formal testing is more prevalent in set than mixed-ability primary schools (McPake, et al., 1999).

Often summative assessments are undertaken with a high degree of trust (Hodgen, 2007) with little space for critical reflection. Given that results of these assessments feed into ability-groupings, trust here has particular implications for the role of such assessment practices in the production and reproduction of ability discourses. Part of this trust seems to rely on the teachers' understanding of the validity of such assessments; there is a belief that the tests measure, and only measure, the concept they name, usually some aspect of mathematical understanding. Conversely, as Black and Wiliam (1998) note in their assessment review, these assessments give a better indication of task completion or pupil motivation than they do of understanding.

Mathematics seems to be susceptible to this dominance of summative assessment with a focus in the literature on formal assessments, testing and examinations (Wiliam, 2007). Even discussion of informal assessment strays into the deterministic, resulting in the various functions of assessment being seen to exist in confusion and tension (Wiliam, 2007). Whilst such a tension exists, it is far harder for assessments to tell us about the qualities of an individual or for individual learning to be supported. In addition, whilst summative assessment, despite some reaction against the pervasiveness of these, continues to be applied uncritically, its dominance may undermine the potential benefits of other assessment practices (Gardner, 2006).

It is important to consider how assessment practices work and play out within discourses of ability. Assessment cannot be conceptualised as 'transparent and unproblematic' (Pryor & Torrance, 2000, p. 110), yet, particularly in the literature dating back only ten years, social processes are generally absent or under researched (Filer & Pollard, 2000), with this only beginning to change recently. Many testing regimes use cut scores to determine where a pupil 'belongs'. They do this without consideration of the human judgement embedded in the process (Wilson, 2007). Assessment cannot be non-subjective, yet it is used as if it is.

So called 'objective' assessments are, Black and Wiliam (1998, p. 58) argue, 'little more than the result of successive sedimentation of previous "informal" assessments'. These 'informal' assessments take account, not of achievement, learning or understanding, but of a teacher's assumptions about a pupil built on extraneous factors such as behaviour, class participation and attendance. Up to a half of teachers have been found to take perceived ability and class performance into account in awarding test marks, whilst nearly two-thirds of teachers actively bring pupil conduct into their task grading (Harlen, 2004b). It is not remarkable, therefore, that National Curriculum assessments of seven year-olds have been found to contain considerable teacher bias (Harlen, 2004a), or that discussion of the self-fulfilling prophecy (Rosenthal & Jacobson, 1992) is profuse in the assessment literature (e.g. Black & Wiliam, 1998).

Given the complex judgements and biases which take place, it is little wonder that many pupils do not understand what is required from them within the assessment process and engage in a process of criteria guessing. Pupils whose classroom experiences are dominated by grading may come to see the grades as 'what counts' (Black & Wiliam, 1998, p. 58), over, in particular, any reference to the mathematical content. Given that pupils may be more focused on assessment outcomes than the mathematics, it is not difficult to see how assessment inflects pupils' ability-identity. Not only supporting the production of identity through its labelling powers, assessment constructs identities directly. Secondary school pupils have been found, through assessment practices, to experience shifts in their personal notions of ability from a more evaluative, to a grade-orientated, position (Hamilton, 2002). Pupils accept their categorisation without question (ibid, 2002). Assessment appears to produce and reproduce pupil ability-identity. Undoubtedly, some aspects of the assessment processes are strongly related to psychometric theory, an innateness conception of ability and the possibility of the measurement of this.

3.3.4 Psychometric theory, ideology and reproduction

Previously I explored the background to an ideology of ability in the UK. It is likely that this ideology underpins assessment practices particularly in relation to ability demarcating practices. The conflation of ability with terms such as achievement and IQ is evident in the use of a variety of measures to inform group assignment, focussing predominantly on statutory, non-statutory and internal written tests (Ireson & Hallam, 2001; Lou et al., 1996).

IQ or cognitive ability tests are frequently used in primary and particularly in secondary schools in addition to, or instead of, Key Stage tests (Hallam, 2002; Ireson & Hallam, 2003; Kulik & Kulik, 1982a), with the ways in which these are interpreted suggesting an adherence to fixed entity views of intelligence and ability (Davies, et al., 2003).

Although there have been changes, our history of ability practices is predicated on a notion of innateness, difference and the need for appropriate schooling for different abilities. Since the rigid streaming and tripartite secondary schooling systems of the 1960s we have moved through different grouping foci in response to changing educational ideologies and the perceived needs of the future workforce. However, despite comprehensivisation, changes may be fairly superficial and actual sustained change, particularly in mathematics, may be fairly limited.

An ideology of ability can be seen in current calls, across political parties, for more extensive setting. The previous Government expected all secondary schools to implement setting and suggested that it may be worth doing so in primary schools (DfEE, 1997). Successive publications to schools promoted ability-grouping (e.g. DfES, 2005; DfES, 2006), and there has been a growing emphasis on ability-grouping and task-matching, particularly in mathematics, within primary schools (Askew, et al., 2001; Ofsted, 1998). The current Government appears to espouse similar views (Gove, 2007). It is argued that ability-grouping allows individual, targeted instruction, responding to the individual needs of the pupils and that with homogeneous groups, teaching is easier, more effective and utilises time most efficiently. Further, it is suggested by proponents that high-achieving pupils are not held back whilst low-achieving pupils participate to a greater extent and hence do not feel stigmatised or inferior. As a result, ability-grouping is argued to reduce failure for all, promoting and retaining positive attitudes towards the subjects and towards learning. Pupils are motivated by appropriate tasks promoting high levels of interest and an incentive to do well, hence raising standards across achievement levels.

There are of course converse arguments, yet these arguments are ones which have been rehearsed repeatedly from original lists of the 1930s (e.g. Hallam, 2002; Hallam & Toutounji, 1996). These arguments come from a vast research and many reviews (e.g. within the UK: Hallam, 2002; Hallam & Toutounji, 1996; Harlen & Malcolm, 1999; Ireson & Hallam, 2001; Kutnick, et al., 2005; Lou, et al., 1996; Sukhnandan & Lee, 1998) stemming from the renewed interest in ability-grouping. However, there is limited consensus within, or uptake of, such research, essentially because it goes against a powerful ideology and seems, to many proponents, particularly those who assume themselves to have most to gain from the practice, to be counter-intuitive. As a result, change in this area has proved to be difficult. Gamoran (2004), drawing on Oakes' (1992) work, has illustrated the multiple barriers to detracking in the US; barriers which would also apply in removing ability-based practices in the UK. Further, Alpert & Bechar (2008) have demonstrated the salience of ability, with assumptions of individual difference and ability-based judgements still being brought into alternative structures. This suggests that change needs to go beyond a terminology change, but instead engage with and challenge the underlying ideology.

There are complex reproductive interactions occurring between ideology and practice. In the following section, I take this further, using the theoretical literature, to explore how we can understand the processes occurring.

3.4 The Effect of Ability Discourses: Justification of the study

Within this review, I have looked at what ability means, its origins and its saliency. I have asked how ability plays out in school practices and what we might mean when talking about ability in terms of pupils' mathematical and learner identities. In this final section, I reiterate the arguments surrounding ability-grouping before discussing the implications of continued reproduction of ability in primary mathematics. I conclude the review through justifying the need for this present study.

The research evidence for ability-grouping is mixed (Norris & Aleixo, 2003), sometimes inconclusive (Sukhnandan & Lee, 1998) and provides few 'answers' (Fuligni, Eccles, & Barber, 1995; Ireson & Hallam, 2003). Generally, often drawing on Slavin's (1986, 1987, 1990) seminal 'Best-Evidence Syntheses' of 17 primary and 29 secondary education studies, whilst accepting some study differences (Kulik & Kulik, 1982a, for example suggest a near zero effect; whilst Linchevski & Kutscher, 1998, report a negative effect), it is reported that overall, grouping by ability is unlikely to raise attainment. Other literature goes further to suggest that we are not even seeing an averaging effect; that ability-grouping has little effect on the mathematical attainment of pupils at any achievement level (Betts & Shkolnik, 2000a). The literature is not simple because the effects are not simple, impinging on complex interacting factors rarely studied together (Hallam, 2002; Ireson & Hallam, 2001) and interacting with other extraneous variables (Betts & Shkolnik, 2000b; Harlen & Malcolm, 1999). There is something particular about mathematics, with teachers viewing grouping as more necessary in subjects with a more structured knowledge base (Harlen & Malcolm, 1999); 80% of UK mathematics teachers (compared with 3% of teachers of English) view mixed-ability-grouping as incompatible with teaching mathematics (Cahan, Linchevski, Ygra, & Danziger, 1996).

Arguments given by proponents of ability-grouping are that it enables efficient whole-class teaching, maximising teacher-input through reducing administration (Askew & Wiliam, 1995), and tailoring teaching to pupils' needs. Arguments align with the intuitive belief that heterogeneous grouping holds back higher-attainers and leaves lower-attainers without appropriate support. There is some evidence that mixed-ability grouping supports lower-attainers and setting slightly, but not significantly, benefits higher-attainers. Within elementary mathematics, Slavin (1987) produces a median effect size of +.32 across five randomised studies of within-class grouping, with low-achievers having the most to gain (ES = +.65) and average attainers experiencing the lowest gains (ES = +.27),[6] although not all studies suggest it to be as effective (e.g. Mason & Good, 1993) and there exist important differences in the breakdown of working relationships in within-class grouping (Kutnick, Blatchford, & Baines, 2002). There is some suggestion that higher-attainers exert substantially more effort in homogeneous groups (Carbonaro, 2005). Venkatakrishnan and Wiliam (2003) found fast-track placement *could* be beneficial, but only for the upper half of the track (see also, Marsh, 2007; Seaton, Marsh, & Craven, 2010; Zeidner & Schleyer, 1998, on the 'big fish, little pond' effect); there is also some evidence that early acceleration may benefit the highest-achievers, at least in terms of self-esteem (Ma, 2002).

[6] Slavin calculated effect sizes as the difference between the experimental and control (heterogeneous group) means divided by the control group standard deviation. Using individual control standard deviations puts all effect sizes in the same metric. Where means/standard deviations were not provided in included studies, ES was estimated from t, F, or exact p values. Where gain scores and pre-post correlations were known, ES were transformed using the multiplier:

$$ES = (ES_{gain})\left(\sqrt{2(1 - r_{pre-post})}\right)$$

(assuming r = +0.08 where unavailable) to account for inflation resulting from lower standard deviations of gain scores (Slavin, 1987, p. 300).

Conversely, opponents of ability-grouping argue that group allocation is biased, subjective and inconsistent (Hallinan & Sørensen, 1987; Stone, 1998; Useem, 1992a, 1992b; Winn & Wilson, 1983). Lower-attainers face limited curricular access (Kifer, 1992), lower quality tasks (Baines, et al., 2003; McPake, et al., 1999) and poorer teachers (Kelly, 2004). Interactions and expectations are limited, as is the scope for social comparisons (Meijnen & Guldemond, 2002; Reuman, 1989) and behavioural models (for further discussion on 'behavioural contagion' see Felmlee & Eder, 1983). Returning to widespread selection is unlikely to raise standards (Ireson & Hallam, 1999). In mathematics, ability-grouping widens attainment; the correlation between initial (year 8 NFER scores) and eventual (GCSE scores) is significantly larger in mixed-ability than setted mathematics classes (Boaler, 1997b). Top-set students achieve 0.58 of a GCSE grade better than would be expected from KS3 scores and bottom-set pupils achieve 0.51 of a grade lower than expected (Wiliam & Bartholomew, 2004). Hence, opponents argue that homogeneous grouping creates, maintains and reinforces underachievement and inequality (Hodgen, 2007; Rowan & Miracle Jr, 1983), effectively streaming pupils (Mulkey, Catsambis, Carr Steelman, & Crain, 2005). Different studies find differences for different subjects/achievement-levels and make different proposals (see for instance, Askew & Wiliam, 1995, p. 38, on 'near-ability' groupings which proposes pupils of adjacent achievement levels being grouped together; and Fuchs, Fuchs, Hamlett, & Karns, 1998, on homogeneous dyads) highlighting the inherent complexities and the need for a pragmatic approach (Reynolds & Muijs, 1999).

There are multiple implications in allowing the reproduction of the current ability ideology: for the continued study of mathematics, the reproduction of negative attitudes towards the subject, and potential effects on social mobility. A US study (White, Gamoran, Smithson, & Porter, 1996) found that students in high/college tracks were far more likely to complete the minimal two-year college preparatory mathematics course (91% as opposed to 2% of students in general tracks). Further, Hallam and Toutounji (1996) have suggested that negative school experiences as found in low-ability groups decrease the likelihood of taking up further training opportunities alongside an increase in maths-anxiety (Brassell, Petry, & Brooks, 1980). Further, a recent Dutch study following a cohort across educational phases suggests that earlier tracking reduces students' likelihood of completing higher education (van Elk, van der Steeg, & Webbink, 2011). Reproducing ability conceptions (which seem to develop early, see Heyman, Gee, & Giles, 2003; Räty, Kasanen, & Snellman, 2002) and correctness as being what mathematics is about carries implications for wider society (Buxton, 1981), whilst Boaler's (2005) follow-up study suggests how the stigmatisation attached to low-group placement impacts on social mobility (see also, Brunello & Checchi, 2006).

3.4.1 The implications of reproduction

Discourses and practices of ability work through determining the way we think of ourselves and others, both as descriptor and explanation. They not only allow, but legitimise, differences in practice within the teaching and learning of mathematics. Whilst it is accepted that, overall, attainment is not increased by ability-grouping, practices do vary dramatically across groups, even with the same teacher. Studies suggest that it is differential teaching practices, teacher allocation and expectations associated with different sets, rather than the sets per se, that results in achievement differences. This has been found to be the case with top groups (Burris, Heubert, & Levin, 2006) but also with groups which are 'high-stakes' to schools. Gillborn & Youdell (2000) have found that scarce educational resources, including experienced teachers, are directed at pupils scoring at the crucial C/D boundary in GCSE examinations, in order to push these pupils up to a C grade and improve the school's league table position. This process, which they term educational triage, has also been found to occur in the US at elementary school level where reading tests act as gate-keepers to Grade 4 entry (Booher-Jennings, 2005). Both Gillborn & Youdell's and Booher-Jennings' studies have found that pupils achieving below the threshold to be triaged into additional input groups are substantially disadvantaged and their attainment suffers as a result of grouping placement practices.

Not only are the teachers different, but teacher behaviour also alters according to set label. Teaching styles, content and classroom interactions are likely to be of a different order across groups as a manifestation of ascribed identities. This interaction difference is argued to underlie, at least in part, the disparity in ability-group outcomes (Wiliam & Bartholomew, 2004), with interactions, over classroom organisation, having a far greater bearing on progression (Brown, et al., 1998). Grouping practices are influential on teaching practices (Eder, 1981; Hallam & Ireson, 2005; Rist, 2000; Rosenthal & Jacobson, 1992). The label of 'low-ability' itself closes down potential experiences resulting in teaching characterised by conceptual simplification, repetition, rote-based learning, topic omission, slowed pace and rehearsal (Harlen & Malcolm, 1999; Schwartz, 1981).

Strengthened through pupils' fixed conceptions of ability (Dweck, 2000; Dweck & Master, 2008), self-fulfilling prophecies allow groups to become the identity ascribed, drawing groups away from each other. There is very little movement between groups (Macintyre & Ireson, 2002), with ability-grouping losing flexibility and becoming more like tracking structures. This moves practice away from Slavin's (1986, 1987) elementary school review finding that if ability-grouping organisations are to be successful there needs to be a frequent reassessment of placements. Given such a tracking effect, grouping by ability seems to widen attainment gaps, with low-achieving students losing much more than higher attaining students may gain. Grouping practices have the inevitable corollary that they must create low-achieving groups (Muijs & Dyson, 2007), with such labels allowing the daily communication of some pupils' lower worth. As placements and misplacements become set (Bartholomew, 1999), group members conform to their set-label as they respond, adapt to, and take on, teachers' concerns (Bibby, Moore, Clark, & Haddon, 2007) with early set placement all but dictating future educational success.

With attitudes being tied up in the identity formations occurring through ability discourse predicated practices, it seems unremarkable that a polarization of attitudes (e.g. Ball, 1981) occurs alongside the more academic success/failure dichotomisation within the identities ascribed to, and developed by, individuals. Whilst positive self-concepts have been reported where pupils are exposed to moderate levels of setting (Ireson, Clark, & Hallam, 2002) this is incompatible with the widespread extensive use of ability-grouping experienced by most pupils. Recent qualitative studies collaborate findings that overall, high levels of ability-grouping have a 'detrimental effect on the attitudes and self-esteem of average and low-ability pupils' (Sukhnandan & Lee, 1998; see also, Zevenbergen, 2005).

Positive attitudes have been suggested where group-fluidity is evident, yet such principles are far from many pupils' negative experiences (Boaler, et al., 2000). Some have argued that ability-grouping can raise the self-esteem of low-ability pupils (Kulik & Kulik, 1982a; Marsh, 2007) yet studies such as Ball's would contradict this. Even for pupils in top-sets the relationships of group position to attitudinal formation is unclear. As Boaler's (1997a) study suggested, attitudes within the top-set are just as variable as attitudes across sets. Perhaps part of the difficulty lies in the fact that, as Gamoran and Berends (1987) caution against, although students in higher groups may appear to have more positive learning attitudes/self-concepts, such studies cannot confirm a causal link between grouping and attitudes. What certainly seems to be the case is that a range of other factors interact with grouping in the production of various effects and separating these out is difficult.

Discourses and practices surrounding ability, being part of the social context of the classroom, work in an interacting matrix of complex ways, impacting on the self-concepts and mathematical-identities of pupils. Whilst group placement is often overtly related to achievement, many of the judgements appear random, with pupils devoting 'time, effort and energy … into generating rational explanations for the groupings' as they try to work out what these mean in terms of 'personal and peer identities' (Bibby, et al., 2007, p. 11). An understanding of difference embedded in an ideology where difference is seen as natural and ability as innate, is somehow communicated even to primary school pupils, with such pupils exhibiting a shared sense of these processes as revealing an intrinsic quality of the individual.

We have a system which creates academic success and failure, with this system being part of, predicated, produced and sustained by, multiple, interacting and complex discourses of ability. We have numerous studies that tell us that something is going on, that there are different practices and that these different practices have different effects on individuals. What we know less about is what allows this to happen. What does ability actually mean within the classroom, how is it communicated, how is understanding shared through discourses and practices and how does this then tie in with the impacts we know about; it is these gaps in our knowledge that this study addresses.

3.4.2 Research questions: Justification

In this final section, I explore how the issues raised in this literature review justify the need for the present study and its design. Existing research tells us about the effects of ability discourses and practices and the implications for allowing their continued reproduction in primary mathematics. We understand the ideological basis of this reproduction and the explanations given for ability to be conceptualised as innate. However, despite knowing that such reproduction occurs, we do not really understand the processes at work in allowing it to occur – particularly around communication to primary pupils – and much of the present literature makes reference to aspects such as 'teacher judgement' without really interrogating the meanings of this. Research on the nature of ability discourses –

conceptions of what ability is to different actors – is limited in primary mathematics and the present study addresses this gap, exploring how language used in the mediation of resources and practices leads teachers and pupils to produce, reproduce, and transform, mathematical-ability.

My research questions in Chapter 1 show it is essential to look at discourse. Educational history has shaped our discourses, acting cyclically with practices (Gee, 1999) and knowing how this might work is a crucial step towards change. I have suggested in this review that it is appropriate to consider mathematics as a special case and it is now timely for a study to be grounded in the primary phase. Whilst primary school ability-grouping has always been the focus of controversy (Davies, et al., 2003), the recent substantial uptake as a result of the standards drive should be leading us to ask important questions about what is happening; questions which seem to be lacking in current government rhetoric.

What happens in primary schools is likely to set up identity formations in and beyond secondary school mathematics, yet much research tends to extrapolate backwards making presumptions about primary practice rather than seeking to engage with this stage. Primary schools are inherently different from secondary schools; they have a different culture (see for example Millett & Bibby, 2004) and experience composition and peer effects in very different ways (Thrupp, Lauder, & Robinson, 2002). Whilst there has been some suggestion that ability-grouping is far *less* complex in primary schools (Sukhnandan & Lee, 1998), the dynamics and practicalities of the particular environment create their own tensions (Davies, et al., 2003); more likely than less complex, we may be looking at a situation that is no less complex, simply different.

4 Methodology and Method

4.1 Introduction

This chapter outlines the research methods, and their methodological implications, used to collect and analyse data in this study. These are considered in relation to the ontological position of the thesis.

This research used a mixed-methods approach to data collection and analysis. This approach is still relatively uncommon in mathematics education which in some respects is still subject to the paradigm wars and the resultant chasm between qualitative and quantitative research. A recent survey of mathematics education articles in research journals (Hart, Smith, Swars, & Smith, 2009) found that less than 30% of articles from the previous ten years used mixed quantitative and qualitative methods; of these less than half had combined qualitative methods with any inferential statistics. Within this latter group, approximately 30% made no integration of quantitative and qualitative data in their discussion and conclusion treating them as separate entities, and less than 8% specifically stated that they had employed a mixed-methods research design in their abstract.

4.1.1 Critical realist research methods

In this section I discuss the mixed-methods approach and how it fits with a critical realist meta-theory. Critical realism does not provide a method and it is within methods that critical realism is most lacking. However, it provides some guidelines and the approach is accepting of many methods, being opposed to the 'unity of methodology' found in positivistic studies (Archer, 1998, p. 190). Additionally, it moves beyond the empiricist view of identifying cause and effect, being concerned with *potential* explanations for *apparent* regularities (Bhaskar, 1975). Scott (2005) argues that critical realism, because of its acceptance of multiple methods, might be well placed to deal with social constructs in educational research.

Some commentators argue that critical realism rejects quantitative methods, but these are not the main commentators in critical realism and this rejection is not supported by Bhaskar. Quantitative research under a critical realist meta-theory is only problematic where the study aims to identify causes and direct effects, or where it disregards the meanings of concepts. This is not what the present study does, and critical realism would support my use of mixed-methods, taking diverse information from a variety of sources to attempt to understand the 'whole' of a situation.

4.2 Research Ethics

Ethical considerations are central to research. This is particularly true in the social sciences. Here relationships between the researcher and the researched bring up many dilemmas, placing the need for reflexivity centrally (Burgess, 1989), hence, the outlining of my positioning within this research in chapter 2.

Research ethics is often conceptualised in terms of standards and guidelines (e.g. BERA, 2004; Economic and Social Research Council, 2005). Whilst these offer a checklist of principles, applying and enforcing them is often less straightforward (Burgess, 1989) and ethical safeguards, such as informed consent, may need to be amended during the research period (Iphofen, 2009). Ethical dilemmas may present themselves unexpectedly; two such issues arose in this study. In one case a school felt they had enough trust in me so as to see aspects of the ethical procedures, particularly around written consent, as redundant and mere formalities and it required careful negotiation to ensure adherence to the ethics frameworks whilst maintaining the established working relationship. In the other, I spent time working individually with a focal-pupil when he withdrew from lessons. This working relationship and the discussions that arose could not have been foreseen and as such it was not possible for the pupil to have given fully informed consent to all aspects of our working relationship. In this case, a workable solution was found through electing only to use data relating to this pupil collected formally. Whilst other rich data emerged, this was not part of the original consented research and as such remains unreported. Nevertheless, it is inevitable that information gathered in these circumstances will have informed the formal aspects of data collection and analysis.

The proposed research was presented to and approved by King's College London Research Ethics Panel (see Appendix B). In doing so, pertinent issues were considered relating to: the recruitment of participants, obtaining informed consent, confidentiality and the anonymity of the participants. The approach to participant recruitment is outlined in section 4.3.3. Schools were free to choose whether to participate. Gate-keepers, class-teachers, pupils and parents/carers were informed of the study and given detailed information sheets (see Appendix B). Written consent was sought from all participants and pupils' and their parents/carers were given the option of withdrawing themselves / their child from the study.

Producing information sheets and giving informed consent presented some ethical dilemmas. As one of the aims of this study was to explore the use of an ability discourse, I needed to avoid using leading language without being misleading in the information given. With the pupils' information sheets, a shortened title, *Grouping and Learning in Maths Lessons*, replaced the full study title. Similarly, whilst the teachers' information sheets did require the full title in order to conform to ethical regulations, I was careful to state the issues I would be researching in a descriptive manner rather than giving any study background. In terms of consent, although each teacher gave written informed consent, there was always a question as to how free they were in making this decision as my access in each school was through a gate-keeper who consented to me being there.

Aside from the checklists it was important to consider the general ethics of the research. Iphofen (2009) asserts that, if poorly designed, research is likely to be unethical, wasting the time of the researcher and participants, decreasing trust and lowering potential future participation in research. As such, consideration was put into the design and implementation of this study and the research design was revisited and amended as required over the course of the study.

4.2.1 Pseudonyms

Maintaining confidentiality, data protection and anonymity were key considerations. Many of these could be addressed through application of the university's REP regulations for data collation and storage. A particular concern relating to the case-study design of this research came in maintaining confidentiality and anonymity as individuals were studied in great detail. It was important, as Simons (1989) asserts, that these participants felt they had control over the information they gave and how they were represented. This was particularly important in building up a research relationship and establishing trust.

In aiding the provision of anonymity, pseudonyms were used for all places and people following a pre-constructed renaming strategy. First names were used for pupil pseudonyms and titles and surnames for staff pseudonyms. At Riverside Primary (used for pilot work) and Parkview there was a mixed use of first and surnames for staff. I was aware that using a title/surname formulation may lead to the data being read differently, projecting a more formal and traditional approach. However, this approach was retained to clearly identify to the reader where data relates to a staff member and where it relates to a pupil.

4.3 Research Design

This research was a multiple case study conceptualised using Simons' (1989, p. 116) distinction of case-study as a 'focus of study' rather than a research method. Cases are seen as 'the building blocks for data collection and analysis' (Burton, 2000, p. 215). The design incorporated both qualitative and quantitative methods. In order to explore the impact of ability across different practices, the research included two diverse school environments, one teaching mathematics through a strong philosophy of setting and the other employing prominently mixed-ability teaching. Within each school, focal-sets, classes, teachers and pupils were followed over one academic year to explore their experiences with respect to ability. Sample selection and rationale are outlined in section 4.3.3.

A variety of research methods were employed gathering data at different levels, for instance exploring general associations through an attitudinal questionnaire then examining these issues in depth in interviews. Quantitative methods included attainment testing and attitudinal questionnaires, whilst qualitative methods involved classroom observation, group and individual interviews and data gathered through hanging about in schools. Each research method and its methodological considerations are discussed in sections 4.4 to 4.7.

4.3.1 Pilot work

My MA and MRes studies served as background studies and a pilot for this research. Further piloting was conducted to test and make amendments to the instruments. Piloting was conducted at Riverside Primary where the MRes study had been conducted. Conducting pilot work at Riverside was a pragmatic decision. This school exemplified many characteristics of, and issues faced by, primary schools in the area. It was likely to typify the schools selected for the main study. Riverside had a higher than average intake of pupils with EAL and SEN. It was felt that if instruments were valid and reliable in this setting they would be suitable for use with pupils in other schools. Further, Riverside was used to having visitors and being involved in research. They were therefore likely to be more willing to participate in piloting work whereas a school having little previous research experience may not have accommodated this process to such an extent.

Prior to piloting, instruments were developed from the literature and previous research. I then identified aims for the piloting relating to potential issues with the research instruments. These were concerned with trialling new methods and ensuring that the instruments were feasible and accessible. I discuss piloting within the individual research method discussions that follow.

4.3.2 Rationale for the research design

The research design was systematic, drawing out the best methods to address the research aims, rather than being tied to a set of methods associated with any particular philosophical approach. Case study is appropriate for addressing the research questions. This case study draws on Burawoy's (1998) extended case method which allows a more general picture to be taken from data collected from unique cases. By being a multiple site case study, this study is less open to criticisms over generalization. The research methods were carefully selected to ensure that they provided valid data. Each research method and the anticipated data were mapped onto the research questions to ensure all questions were answered and that the use of each method was justified. A table documenting this mapping is in Appendix C.

4.3.3 Sample: Schools, pupils and teachers

Table 1 outlines the sample: schools, sets/classes, pupils and teachers. The initial plan was to recruit two demographic, attainment, and CVA matched primary schools of at least two-form entry, where one had a strong history of setting for mathematics and the other had a strong mixed-ability ethos. Two-form entry was important, providing a higher practical possibility for the use of between-class setting if desired. Finding a fully mixed-ability school proved impossible, hence a school using limited ability-grouping was sourced. Parkview was sourced through supervisor recommendation as being as close to a two-form entry mixed-ability model as possible. Having established access I collected demographic and attainment data and sourced a closely matched fully setted school, Avenue, using specific selection criteria.

Within each school I followed classes/sets from years 4 (ages 8-9) and 6 (ages 10-11). These year groups were chosen based on my previous study, the literature, pragmatics, and the desire to explore the impacts of external assessment at the end of KS2 (year 6). The whole cohort of Years 4 and 6 were included in the quantitative elements – attainment tests and attitudinal questionnaires – in order to explore patterns across year-groups and between schools. The qualitative elements involved two classes/sets in each year-group, ensuring manageability. At Parkview all classes in the target year-groups were involved; the pupils remained in their classes in Year 4 and were split into two sets in Year 6. At Avenue, where three forms were split into four sets, I worked with the top and bottom sets in each year-group as working at the extremes was likely to yield the richest data. The eight teachers of these classes and sets were focal-teachers of the study.

Based on pilot work and a feasibility study, I elected to have three focal-pupils from each class/set representing the attainment range in each. I asked the teachers to select these pupils. The only instructions given were that they should select a high, middle and low-achiever with respect to the achievement range in the class/set and select pupils that were unlikely to leave during the year (Avenue made special provision for Forces children; these children were excluded as they often joined or left the school at non-traditional times). I compared the teacher-selected pupils with the first administration results of the attainment test to ensure that there was no major bias in selection with, for instance, a teacher giving me higher attainers. The results did not reveal any such bias, but they did show many pupils were mismatched according to my test results. However, the pupils selected provided a cross-section of attainment and it was felt valuable to retain these pupils and explore the teachers' reasoning in interviews. With three focal-pupils in each class/set, I followed 24 focal-pupils.

School	Year-Group	Set/Class	Research Methods	Total pupils	Focal-Pupils	Focal-Teachers
Set School (Avenue Primary)	4	Set 1	Quantitative/Qualitative	30	1 x high-achiever 1 x middle-achiever 1 x low-achiever	Set-teacher
		Set 2	Quantitative only	30		
		Set 3	Quantitative only	19		
		Set 4	Quantitative/Qualitative	11	1 x high-achiever 1 x middle-achiever 1 x low-achiever	Set-teacher
	6	Set 1	Quantitative/Qualitative	31	1 x high-achiever 1 x middle-achiever 1 x low-achiever	Set-teacher
		Set 2	Quantitative only	31		
		Set 3	Quantitative only	17		
		Set 4	Quantitative/Qualitative	9	1 x high-achiever 1 x middle-achiever 1 x low-achiever	Set-teacher
Mixed-Ability School (Parkview Primary)	4	Class 1	Quantitative/Qualitative	24	1 x high-achiever 1 x middle-achiever 1 x low-achiever	Class-teacher
		Class 2	Quantitative/Qualitative	28	1 x high achiever 1 x middle achiever 1 x low achiever	Class-teacher
	6	Set 1A	Quantitative/Qualitative	21	1 x high-achiever 1 x middle-achiever	Set-teacher
		Set 1B		14	1 x low-achiever	
		Set 2	Quantitative/Qualitative	19	1 x high-achiever 1 x middle-achiever 1 x low-achiever	Set-teacher
Totals	4	13		284	24	8

Table 1: Research sample

4.3.4 Research timetable

I completed a feasibility study in the form of a research timetable as I constructed the research design, allowing me to establish the research that could be conducted as a sole researcher in the time available. The research design is shown in Table 2. This gives the totals of pupils, classes and sets that consented to be involved. At the end of the study I had less than 568 data entries for the attainment tests and questionnaire data as some pupils had missed either or both administrations.

Table 3 translates Table 2 into research hours. The total of 662 hours represents a third of a year fulltime equivalent for actual data collection and transcription hours and not the true time spent in schools. My research needed to fit within the timetables of the schools. Logistically, I could only observe one set lesson per year-group per day. Additionally, I had to find appropriate times to withdraw pupils for interviews, particularly Year 6 pupils who were engaged in SATs revision. These gaps were not wasted as I had relative free access allowing for a continual process of informal data collection.

	Set / Class	Attainment Tests	Attitudinal Questionnaires	Observations	Pupil 20 min Individual Interviews	Pupil 30 min Group Interviews	Teacher 30 min Individual Interviews
Set School	Year 4 Set 1	30 pupils x 2 tests = 60	30 pupils x 2 questionnaires = 60	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
	Year 4 Set 2	30 pupils x 2 tests = 60	30 pupils x 2 questionnaires = 60				
	Year 4 Set 3	19 pupils x 2 tests = 38	19 pupils x 2 questionnaires = 38				
	Year 4 Set 4	11 pupils x 2 tests = 22	11 pupils x 2 questionnaires = 22	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
	Year 6 Set 1	31 pupils x 2 tests = 62	31 pupils x 2 questionnaires = 62	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
	Year 6 Set 2	31 pupils x 2 tests = 62	31 pupils x 2 questionnaires = 62				
	Year 6 Set 3	17 pupils x 2 tests = 34	17 pupils x 2 questionnaires = 34				
	Year 6 Set 4	9 pupils x 2 tests = 18	9 pupils x 2 questionnaires = 18	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
Mixed-Ability School	Year 4 Class 1	24 pupils x 2 tests = 48	24 pupils x 2 questionnaires = 48	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
	Year 4 Class 2	28 pupils x 2 tests = 56	28 pupils x 2 questionnaires = 56	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
	Year 6 Set 1A	21 pupils x 2 tests = 42	21 pupils x 2 questionnaires = 42	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
	Year 6 Set 1B	14 pupils x 2 tests = 28	14 pupils x 2 questionnaires = 28				
	Year 6 Set 2	19 pupils x 2 tests = 38	19 pupils x 2 questionnaires = 38	2 per term = 6 observations	3 pupils x 1 interview = 3	1 group of three x 2 interviews = 2 group interviews	1 interview
Totals	**13 Classes**	**568 Attainment Tests**	**568 Attitudinal Questionnaires**	**48 Observations**	**24 Individual Interviews**	**16 Group Interviews**	**8 Teacher Interviews**

Table 2: Research design

Term	**Attainment tests**		**Attitudinal questionnaires**		**Observations**		**Interviews**		**Reflexive Journal (@ 1 hr per research site visit)**	**Total**
	Collection	**Marking/data Collation (@ ~20 minutes per test)**	**Collection**	**Data Collation (@ ~15 minutes per sheet)**	**Collection**	**Writing up of field notes (@ 3 hrs per hour)**	**Collection**	**Transcription (@ 4 hrs per hour)**		
One	2	95	2	71	16	48	4	16	10	**264**
Two	0	0	0	0	16	48	12	48	10	**134**
Three	2	95	2	71	16	48	4	16	10	**264**
Total	**4**	**190**	**4**	**142**	**48**	**144**	**20**	**80**	**30**	**662 hours**

Table 3: Research hours

4.4 Attainment Tests

Attainment tests were used across the pupil cohort (n = 284) at the beginning and end of the research period to explore attainment levels and gains. The tests were taken from those used within the *Leverhulme Numeracy Research Programme* (LNRP) at King's College, London (Brown, Askew, Johnson, & Street, 1997-2003). This was an aurally administered test with individual pupil answer booklets (Appendix D), tiered, but with a common format for different age-groups. Given that these tests have been through extensive development and use and were used without adaptation, and without the need for extensive piloting, this is a purposely brief section. The foci of this section are my rationale for using this test and my analysis of the data.

4.4.1 Instrument choice

The LNRP tests were developed from those administered during the King's College *Effective Teachers of Numeracy* project (Askew, et al., 1997) and previous King's College research (Denvir & Brown, 1986a, 1986b, 1987). Overall, this represents over 30 years of development and a shift from one-to-one diagnostic interviews to whole-class tests with items reflecting the Primary Framework. The test design, validity and administration are discussed in detail in Appendix 1.3 of ETN (Askew, et al., 1997, pp. 101-108).

Using previously constructed rigorous standardized tests carried many benefits. I could be more confident in the validity and reliability of my data and vast quantities of data exist on pupils who have undertaken these tests. This enabled me to use previous data to calculate maths ages and to use these in making comparisons. Further, the test was designed so that the majority of pupils would have been able to make an attempt at answering each question. This was important in terms of the ethics of the study and on the impact of this instrument of researcher-subject relationships. If the pupils had been given a test which had intensified feelings of low-ability this may have impacted on their willingness to engage with me, for instance in interviews.

Previous studies using these tests demonstrated their validity in measuring pupil gains. Further, extensive statistical work has been applied to the ETN test data to allow for the inclusion and comparison of pupils of all attainment levels, including high-achievers in the first administration, through the production of a formula to calculate adjusted gains. This was particularly important, as it allowed me to examine the value that different classroom organisational arrangements was adding, without negatively impacting on top sets with initially high attainment.

4.4.2 Attainment test administration

The attainment test was administered in October 2007 and July 2008. The same test was used for each administration. Separate papers were used for Year 4 and Year 6 pupils, although there were common items. Prior to the research, I spoke to the teachers who would administer the test, talking them through the administration instructions. Each teacher was provided with a set of pupil answer booklets, a teacher script and teacher instructions.

Teachers read out the questions following a script, with questions repeated as directed. Pupils answered directly in their booklets, with most questions requiring short answers or multiple choice. Some questions required a visual display, for instance depicting sets of items. Teachers were provided with a poster copy of the item and given the item on CD to present on an Interactive White Board and teachers chose which to use.

After the first administration I spoke with each teacher so ascertain any administration difficulties. Two concerns that arose were time and access for the lowest achieving pupils. I addressed these, reiterating that it was acceptable to move on before all pupils had finished. Additionally, I assured particular teachers that it was acceptable for them to withdraw pupils from the second administration. Across the sample, three pupils were withdrawn by teachers for the second administration and teachers did not report difficulties with time during the second administration.

4.4.3 Attainment test analysis and reporting

Pupil booklets were marked and the results for each part question for each pupil entered into Excel spreadsheets. Pupils were assigned a code number to ensure confidentiality and aid in matching data to the attitudinal questionnaires. Basic demographic data was added to this spreadsheet. Binary 1/0 coding was used throughout the spreadsheet. Total scores were converted into percentages and maths ages following the LNRP formulas for Year 4 and Year 6 respectively:

Year 4 maths age = (raw score x 0.106) + 4.4

Year 6 maths age = (raw score x 0.098) + 6.65

Having entered all the data from administration one the spreadsheets were systematically cleaned. Pupils who had not completed the test were removed, and the spreadsheets were ranked, totalled and visually inspected for inconsistencies, for instance unexpected facility rates and possible outliers which may have indicated an error. Potential errors were assessed and if necessary rectified. A random sample of 15 pupil booklets (approximately 5%) was checked against the entered data to assess the reliability of my data entry. This revealed four entry errors across 1129 items, representing well over 99% accuracy. Once cleaned, the data were imported into SPSS. Statistical analyses were conducted to establish the characteristics of the data and appropriate statistical tests.

The first administration data was graphed and descriptive statistics, Kolmogorov-Smirnov tests of normality, and z-scores for skewness and kurtosis calculated. The data appeared to follow a normal distribution. The distribution was significantly negatively skewed ($Z_{skewness}$=-2.38), i.e. slightly more scores fell in the upper range, and somewhat flat ($Z_{kurtosis}$=-1.18) although not significantly so. A Kolmogorov-Smirnov test of normality showed the overall percentages on the attainment test, $D(236) = 0.05$, $p > 0.05$, did not differ significantly from a normal distribution. A normal Q-Q plot illustrated this, with the observed values only deviating from the expected values at the extremes. These results were expected given that the instrument's development, and from this it was concluded appropriate to use parametric tests.

Following the second administration, the results were collated, entered into the spreadsheets, cleaned and checked as before. Gains were calculated in raw scores. The majority of gains were positive; negative gains were checked for data entry errors. With some higher achieving pupils there was less room for gains. An adjusted gains formula developed in ENT resulted in adjusted gains being expressed as a proportion of the total possible gain for each pupil:

$$\text{Adjusted gain} = \frac{b - a}{a(T - a)}$$

where: a – first administration score, b – second administration score, T – total possible score.

Within the main analysis, I used the second administration data when reporting attainment scores as this dataset was larger and reflected the impact of the organisational conditions pupils had been exposed to over the year. Due to this test being used as a research instrument, no feedback on individual questions or results was given to teachers following the first administration. Following the second administration written feedback was given to each school (see Appendix E).

4.5 Attitudinal Questionnaires

Attitudinal questionnaires were used across the pupil cohort (n = 284) in October 2007 and July 2008. The questionnaire instrument was adapted with permission from Nicholls' instrument (Nicholls, Cobb, Wood, Yackel, & Patashnick, 1990), and is included in Appendix F (the instrument is also disccused in Duda & Nicholls, 1992; Nicholls, 1989; Nicholls, Cheung, Lauer, & Patashnick, 1989; and Nicholls, Patashnick, & Nolen, 1985; the following discussion draws on all these sources). The questionnaire was administered to whole classes and required pupils to select, on an adapted Likert scale, how strongly they agreed with items relating to two constructs: motivational orientation, and beliefs about the causes of success. Further items asked pupils to rate their perceived ability and how much they liked maths on a graphic scale.

4.5.1 Instrument choice

Research on affective issues has a long history and has generated considerable interest within mathematics education (i.e. Askew, et al., 2010; Leder & Forgasz, 2006). However, commentators (e.g. Leder & Forgasz, 2006) have noted many difficulties and constraints in measuring attitudes as beliefs are complex and variables often poorly defined. Given these difficulties and there being no 'best test' (Kline, 1990, p. 107), I selected and modified an instrument carefully to suit the study needs. McLellan (2004) suggests that the adaptation of existing instruments is preferable to producing new instruments, particularly where instruments have been devised by key researchers and have established validity and reliability.

Nicholls was one of the earliest researchers of goal-theory and achievement motivation, hence the motivational scales developed by the group being some of the most acknowledged and widely used. The instrument I used developed out of Nicholls' earlier research, and has since been used widely by members of the same research group, both in mathematics education (e.g. Cobb, Wood, Yackel, & Perlwitz, 1992; Cobb et al., 1991) and beyond (e.g. Duda & Nicholls, 1992). In addition, the instrument has a long history outside of the research group involved in its development. From its inception, the scales were favourably acknowledged (e.g. Meece, Blumenfeld, & Hoyle, 1988), and this continues to be the case in recent reviews (Covington, 2000; Kaplan & Midgley, 1997). The adaptation of the instrument across its lifespan (e.g. Meece, et al., 1988; Yates, 2000) further serves to justify my use.

4.5.2 Instrument sub-scales

Nicholls' instrument consists of three sub-scales: motivational orientation, beliefs about the causes of success and perceived ability. Each sub-scale is relevant to an aspect of my study and all were used.

4.5.2.1 Motivational orientation scale

Motivational orientation assesses the extent of pupils' ego-orientation, task-orientation and work-avoidance. The extents to which pupils' goals are ego-orientated (seeking superiority over others) and task-orientated (seeking understanding of the taught material) has implications for how they see themselves and others. Ego and task orientations are independent and not dichotomous; pupils will have a position on both scales.

McLellan (2004) provides a substantial critique of Nicholls' motivational orientation scales. Working through the instrument development from its 1985 conception (Nicholls, et al., 1985), she concludes that Nicholls' scale gives both a reliable and valid measure of pupils' motivational orientation. McLellan considered several other motivational-orientation instruments as sources of items for her questionnaires, yet decided these added nothing to Nicholls et al.'s instrument. My decision to keep the instrument as a whole appears to be further justified in light of McLellan's findings.

4.5.2.2 Beliefs about the causes of success

Beliefs about the causes of success in mathematics comprised of a set of items assessing the extent to which pupils hold beliefs that success depends on effort and trying to understand the mathematics, superior ability and attempts to do better than others, and task-extrinsic behaviours. These are seen as independent, with pupils aligning to each belief to a greater or lesser extent.

In her critique, McLellan raised some concerns about the earlier forms of the instrument and the unreported rationale for item grouping, but suggests later developments, including the 1990 paper I based my instrument on, were more conceptually 'sophisticated', with construct validity and adequate alpha levels resulting in a sufficiently reliable instrument. Whilst McLellan included additional items, I felt these were less relevant to my study (for instance the addition of 'people do well if they are better than others at taking tests' suggests some understanding, on the part of the pupils, of examination techniques, which would be less relevant to year 4 pupils, whilst 'people do well if they know how to make themselves look clever' may be a difficult concept for younger children to comprehend). Given that it was the constructs, rather than a limitation of Nicholls' instrument, that led to these changes, this consideration was unrelated to my study, and further items were not needed.

4.5.2.3 Perceived Ability

Perceived ability was measured differently from the scales assessing motivational orientations and beliefs about the causes of success. This was presented as a one item scale asking pupils to indicate their perceived standing in mathematics related to their peers, and having high test-retest reliability (0.83). Unlike other scales which combine perceived ability with other items, Nicholls presented this as a separate scale in order that pupils did not conflate motivational orientations with this item.

Nicholls did not find perceived ability to be appreciably associated with pupils' goals, with this item dropped in later instrument developments (Cobb, et al., 1991). However, this scale seemed important for my study and was kept, although as validity debates abound over what the instrument measures, and I adapted the item from the original schematic faces to a linear presentation, piloting was essential.

4.5.3 Psychometric and statistical properties

In this section I discuss the statistical issues and related psychometric properties that apply to the instrument and my construction.

4.5.3.1 Factor analysis

Factor analyses were central to the construction of this instrument. Exploratory factor analysis uses the correlations between items to reduce the number of constructs (Kline, 2000). It provides factor loadings, giving the correlation between each item and the newly produced factors, indicating how much a factor explains the variance of an item. Confirmatory factor analyses supported the hypothesis of a meaningful relationship between goals and beliefs about the causes of success (Nicholls, et al., 1990). There are many types of factor analysis, with the simplest being principle components analysis (Cramer, 2003). This method is used by both Nicholls and by McLellan, although McLellan noted that where different methods were used, the results were similar and hence she only reported the principle components factor analysis.

4.5.3.2 Test construction and item selection

Only the instrument items and their scoring were available through the research papers or authors. Therefore, issues of test construction were central to my use of the instrument. Given the proven reliability and validity of the original instrument, I wanted to retain as much of the original as feasible. The 1990 instrument related solely to mathematics; given that I was working within mathematics, I constructed my instrument from this paper.

Nicholls' questionnaire was intended for a non-British audience and the language reflects this. I went through the questionnaire and using my familiarity with the language capabilities of pupils modified US language for a British audience. This process resulted in changes to six items across both constructs as highlighted in Appendix F. The majority of the changes were minor, for instance changing 'math' to 'maths'. It was not felt these changes would impact on the established psychometric properties of the instrument. Having changed the wording, I conducted the questionnaire with a focus-group of four pupils at Riverside Primary. Each item was discussed to explore pupils' understanding of the item. The format was found to be simple for pupils to understand. Some pupils benefited from clarification to three items, for instance adding the context of knowing more than other children to knowing more than others. It was assessed that these changes, highlighted in Appendix F, would not affect the psychometric properties of the instrument.

A further consideration was the positive wording of the items. All of Nicholls' items are phrased positively in terms of success, something Kline advises against (2000), as it may lead to acquiescence. McLellan addressed this in her study by using matched opposition items during piloting. However, she found the structure arising from her additional 'failure' items less clear than the structure arising from Nicholls' 'success' items. On this basis, I retained Nicholls' success orientated instrument particularly as it had been used this way in several previous studies.

Nicholls presented the motivational orientation scale before the beliefs about the causes of success. I wanted to reverse these, giving beliefs first. Beliefs was the most pertinent construct for my study, and I felt that this order gave the benefit of presenting a general case before the individual case (beliefs has the stem 'pupils do well if …' whilst motivational orientation has the stem 'I feel really pleased when …') reducing the possibility of pupils focusing only on their experience. McLellan suggests the need to retain the original order to ensure one section does not influence the outcomes on a later section. Whilst this warranted consideration, I felt a beliefs first approach was justified in that Nicholls' factor analysis had revealed these as separate constructs that can be meaningfully related.

Nicholls' instrument uses five point Likert scales for responses to the motivational orientations and beliefs scales. A concern with a five point scale is discrimination. However, my piloting recorded an item standard deviation range of 0.56 to 1.66. Whilst these appear low, McLellan (2004, p. 132) records a range of 0.66 to 1.09 for her beliefs scale, yet labels this as reasonable. In addition, the factor analysis presented by Nicholls was conducted on data arising from a five point scale; to change this would result in the need for greater piloting. Further, it seemed reasonable to keep the number of categories young pupils were expected to hold in their heads low. Kline suggests a graphic scale to be preferable to a numerical scale. This is the method employed by Nicholls (i.e. **YES**, yes, ?, no, **NO**, instead of 5, 4, 3, 2, 1) and I saw no need to change this. Additionally, my piloting found this scale to be easily understood, further justifying its retention.

In Nicholls' earlier study (Nicholls, et al., 1989) the authors found the accuracy of students' ratings of ability was higher in instruments that allowed for some form of ranking. The authors achieved this by presenting a vertical line of 18 schematic faces labelled 'does best in math' at the top of the page and 'does worst in math' at the bottom of the page and asking students to circle how good they were at mathematics. Given the theoretical basis of this item, I decided to retain ranking, but trialled different item formats. Schematic faces where found in piloting to be difficult for some pupils, particularly where the number of faces did not correspond to the number of pupils in their class. As my study involved classes of different sizes, it was not feasible to provide a representative line for each pupil so I used a linear scale. This was presented horizontally, matching the format of the questionnaire but retaining similar language to Nicholls' instrument being labelled 'best in maths' at one end and 'worst in maths' at the other. Pupils marked the line to indicate how good they were at mathematics. Further piloting interviews suggested that this was easy for the pupils to understand and use.

A second identical line was added to explore how much pupils liked maths. This was not an item in Nicholls' instrument but was felt to be important in exploring how pupils' orientations, beliefs and perceptions were interwoven with levels of enjoyment. Nicholls warns, although does not expand on this, that items asking about liking for schoolwork 'artificially inflate associations between perceived ability and task orientation' (Nicholls, et al., 1990, p. 114). As no further explanation of this issue was provided and the item was deemed important for the study, I retained it but ensured this was the last item of the questionnaire so it did not impact on earlier answers.

4.5.3.3 Reliability and validity

Reliability

Two forms of reliability were important; test-retest and internal consistency. Test-retest reliability gives a correlation of the agreement between respondents' answers to the test on two separate occasions. This was particularly important as I needed to know whether changes over the year were real changes or changes related to measurement error. Addressing this, it was important that I use an instrument where such issues had previously been considered. Unfortunately, Nicholls does not report test-retest correlations. However, as this instrument has been used on multiple occasions within and beyond the designing research group, I could be reasonably certain that any major measurement errors will have been cited previously.

Internal-consistency reliability has links with the validity of the test. It provides a correlation between the items and the construct they are intended to measure. Hence, to be valid, the test needed to have high internal consistency (Kline, 2000). Kline suggests that the correlation (the alpha level) should not drop below 0.7 because the standard error increases as the alpha level decreases. Alpha levels within Nicholls et al.'s (1990) instrument range from 0.55 to 0.76, with a mean of 0.66. McLellan (2004) also produced alpha levels of this magnitude but noted, drawing on Henerson, Morris and Fitz-Gibbon's (1987) work, that lower alpha levels are acceptable in attitudinal measures. McLellan had to conduct more work on the scales she had adapted most to bring alpha levels up to an acceptable level. This may suggest some merit in my decision to retain the original instrument.

Validity

Validity, unlike reliability, can be harder to assess as it cannot be ascribed an abstract level or be dealt with as a technical matter (Anastasi, 1982). Construct validity is considered one of the most important approaches to validity, exploring the extent to which the instrument represents the named construct (Henerson, et al., 1987). Given that construct validity can be difficult to defend, involving, for instance, appeals to logic, it seemed justified to use a widely employed instrument where such arguments have been rehearsed repeatedly.

4.5.4 Questionnaire administration

Prior to the research period, I spoke to the teachers who would be administering the questionnaires as well as providing them with written instructions to ensure that the questionnaires were administered in the same way. I sat in on one lesson where the questionnaire was completed without partaking; from this I was satisfied that it was being administered as intended. I spoke individually with each class-teacher when I picked up the completed questionnaires to ascertain whether any issues had arisen. The only issue was that of the time the questionnaire took to complete; I addressed this during the second administration by asking teachers to emphasise that I was interested in initial thoughts and that pupils did not need to think about their answers. I also assured teachers that it was acceptable to withdraw any child that struggled excessively; this applied to three pupils statemented for SEN across both schools.

During administration teachers explained to the pupils why they were completing the questionnaire and were asked to reassure them that answers would remain confidential and there was no correct answer. Pupils were asked to look at the first set of questions assessing beliefs about the causes of success. Their attention was drawn to the question stem – children do well in maths if… – with it being explained that this preceded every question. The Likert scale was then explained. Teachers were provided with large paper and/or interactive whiteboard examples in order to allow explanation of the scale and answering methods. Using the examples given, teachers explained the difference between a ‘big yes’ and a ‘little yes’. Each question was read out including the question stem, giving pupils time to select their answer. Individual support from the teacher and TAs was given as required. The same process was repeated for the motivational orientation scale. For the perceived ability and liking for mathematics items, teachers used an example item to explain the response scale and teachers were asked to clarify that the line represented the whole of Year 4 or Year 6 and that pupils should answer based on that premise.

4.5.5 Questionnaire analysis and reporting

An Excel spreadsheet was created to contain all pupil responses. Numerical data indicating the pupil’s gender, school, year and set was also added. Each pupil response was converted from the graphical scale – **YES**, yes, ?, no, **NO** – to a numeric scale – 5, 4, 3, 2, 1 – when entered into the spreadsheet. Any responses that were missing – and these were very few as a result of the administration process – were noted with an M.

I then calculated mean scores for each pupil for each factor. Where data were missing, means were calculated based on the number of given answers. The mean scores allowed me to rank the motivational orientations and beliefs about the causes of success for each pupil and to see which each pupil held as most important. For the perceived ability and liking for school scales, pupils’ responses were measured and converted to a score out of 100: a score of 100 would occur where they had placed themselves at the very end of the line at ‘best in maths’ / ‘really like maths’ and a score of 0 would occur if they had placed themselves at the opposite extreme.

Pupils' responses from the second administration were added to the spreadsheet. Changes in each construct were calculated by taking the first administration score away from the second administration score. A negative change score indicated that adherence to that belief/construct had reduced whilst a positive change score indicated an increase. Changes in perceived ability and liking for school were calculated in the same way giving an indication of whether pupils' perceptions of their ability and their liking for school had increased, decreased or remained stable.

Having entered all the data the spreadsheet was systematically cleaned. Pupils who had not completed one or both administrations were removed from the relevant dataset. The spreadsheet was ranked by each construct to visually inspect for any inconsistencies, for instance mean values greater than 5 or less than 1 which would indicate an error. A random sample of 5% of the original questionnaire papers was checked against the entered data to assess the reliability of my data entry system. This revealed five data entry errors for individual items, representing over 99% accuracy. The cleaned data sets were imported into SPSS.

Following the first administration, statistical analyses were conducted with the perceived ability and enjoyment items to establish the characteristics of the data and appropriate statistical tests for the main analysis. This was important as these items did not have the same established psychometric properties as the rest of the instrument. The distribution of the data for each item was graphed, then descriptive statistics, Kolmogorov-Smirnov tests of normality, and z-scores for skewness and kurtosis calculated. These tests were also applied to the data grouped by schools, where boxplots and Levene's test were additionally used to ascertain whether the variances were significantly different. Where the Kolmogorov-Smirnov test suggested a distribution to differ significantly from a normal distribution, the sample size and overall shape of the distribution were considered and log, square root and reciprocal transformations of the data trialled. The perceived ability data produced a distribution that did not differ significantly from a normal distribution, $D(219)=0.06$, $p=0.08$, allowing the later use of parametric tests. The distributions of the enjoyment scale data did not differ significantly from a normal distribution for Parkview but did for Avenue. However, it was considered that the overall distribution was near normal and that the parametric tests were robust enough for them to be used on the untransformed data.

I used the second administration data when reporting on perceptions of groups; this dataset was larger and it was felt that these results more accurately portrayed the experiences of the pupils over the research period. Across the dataset, descriptive and inferential statistics were used. Analysis was conducted at a variety of levels: the entire dataset, year-group splits, or set splits to provide comparative data and data was explored within and between constructs to respond to the research questions.

4.6 Classroom Observation

Over the course of the study I conducted six pilot observations, 48 main study observations and numerous informal observations. These built on MRes observational work. The purpose and justification of using observational research was considered carefully and has been discussed previously. In this section I discuss my development and use of observations and the transcription of the data.

I planned to use observation in different ways to the MRes study integrating both quantitative and qualitative analysis of the same observations. Objectives were produced and observational instruments intensively piloted (see Appendix G). However, integrated quantitative/qualitative observations were found to be inappropriate for this study and hence annotated field notes were used as the main data collection method.

4.6.1 Field notes and research journal

In addition to planned observations, being in schools resulted in informal observations. To record these I kept a daily research journal (see Appendix H) making particular reference to any critical incidents. I set aside time each day to add to this, giving my thoughts on what I had observed and done that day and jotting down possible ideas for data analysis, for instance emerging themes. Such 'incipient theorizing' (Jaworski, 1998, p. 119) helped to create a fuller picture of the mechanisms occurring and provided a further source for triangulation.

Within each formal lesson observation, I considered the lesson as a whole but focussed on the interactions of the focal-pupils in each class/set. During observations my position within the classroom was often determined by the physical layout of the room and the teachers' preferences. In all cases, I aimed to sit as unobtrusively close to the focal-pupils as possible. This was easy in smaller sets; in larger sets I changed my position where possible to be closer to different focal-pupils for different parts of the lesson. I tended to stay in one place for the introductory activities and plenary session, but sat with different pupils during the pupil activities. During my observations, I inhabited a fluid role between the traditionally defined ethnographic roles of participant-as-observer, observer-as-participant and complete observer (Bryman, 2001) rather than being defined by any one tradition. Typically the introductory and plenary phases involved higher levels of observation, whilst the pupil activities involved a greater level of participation.

The differing positions and roles I took on during the observations enabled me to gain insights into pupils' perceptions, hence providing data in more informal situations than in interviews. In my fieldnotes I wrote extensive notes on the context of the lesson, critical incidents during the lesson and pupil-pupil and pupil-teacher interactions. I used and kept to hand a copy of my research questions and objectives to guide my observation, but I was not limited by this and recorded what seemed important at the time of the observation. I also used my fieldnotes to record the activities pupils were presented with, and where important their responses. As well as text, I used diagrams and tables to contextualise the fieldnotes. At the end of each research day I annotated my fieldnotes, adding contextualisation that I had been unable to record during the lesson but which it was important I did not lose. Where I had examples of teachers' planning, pupil activities or pupil work, these were also included.

4.6.2 Observation transcription

My annotated fieldnotes were written up fully as soon as possible after each observation. This process served a number of important functions. It allowed me to revisit the lesson away from the classroom setting. I was able to include fuller detail in places I had used shorthand, notes and quick sketches due to time constraints during the observation. Copies of plans, activities and pupil work were included at the appropriate places if referred to in the notes. I was able to demarcate critical incidents relating to the focal-pupils and to label these appropriately. Later thoughts were also added in and labelled accordingly, allowing me to build up a picture of the development of my data analysis. These notes were then imported into NVivo to begin the analysis stage. An example of the completed fieldnotes can be seen in Appendix I.

The observation fieldnotes and interview transcripts were coded and analysed together in order to ensure the same coding structure was applied and to allow for triangulation. This is discussed in section 4.8.

4.7 Interviews

Prior to the main research, I piloted two individual pupil interviews and three group interviews at Riverside Primary. These allowed me to develop and extend the MRes interview instruments. Within the main study, I conducted 25 individual pupil interviews[7], eight group interviews and eight follow-up group interviews with pupils. I developed the teacher interviews during the research period; I piloted these with one teacher who left Parkview before the end of the research period and I subsequently conducted seven individual teacher interviews. Each interview was audio-recorded and transcribed. In the following subsections, I explain the use of each interview type in detail.

4.7.1 Objectives and question development

I justified the use of interview research within Appendix C. It was important to have three interview foci – individual pupils, groups, teachers – as each addressed different aspects of my research questions, and allowed for triangulation. Whilst I had used similar interviews previously, I developed them greatly for the present research. I began with my key objectives (see Appendix J) for each to ensure that the instrument produced useful data. The objectives for my interview research were quite extensive. Some of the objectives were similar to those for the observations and the attitudinal questionnaires. This allowed for triangulation, addressing specific concerns with the validity of the perceived ability item in the questionnaire.

I began to develop my interview questions from these objectives. I sought opportunities to explore qualitatively items from other instruments, particularly the questionnaire. Some items were taken or adapted from previous studies of ability-grouping (e.g. Davies, et al., 2003; Hallam, Ireson, & Davies, 2004b; Kutnick et al., 2006). This provided a direct link with the literature and allowed me to explore in my analysis how my results reflected existing literature. I also made use of Personal Construct Theory (PCT) in devising the individual –

[7] I interviewed Sam twice as he initially found the experience difficult but later asked to be interviewed again.

both pupil and teacher – interview schedules. The background to Personal Construct Theory is given in Appendix J.

4.7.2 Focal-pupil Personal Construct Interviews

An interview schedule and tasks were developed. The interviews were semi-structured, developed as conversations with themes explored as brought up by the pupils. The interview schedule predominantly acted as a guide to key themes and ensured consistency in the task administration. In constructing the schedule, transcripts from earlier interviews were revisited to explore which questions were successful in eliciting pupils' perspectives. The successful items were compared with the interview objectives to identify gaps. Here, items from the literature were explored to respond to these objectives and additional items added as necessary. The pool of items was logically ordered, ensuring a mixing of question types. Three guiding tasks: perceived ability, feelings and classroom plan, were added to break up the interview into manageable sections and to add interest for the pupils. The schedule is given, and tasks explained, in Appendix J.

The interview questions and tasks were piloted with two pupils at Riverside Primary. In addition to piloting the timing at the interviews and the accessibility of the tasks, I also asked these pupils detailed questions around the tasks to ensure their understanding was the same as mine, ascertaining that the tasks were reliable and valid. Within the main study, each interview was conducted individually and on separate days. This was deemed important as it ensured my notes and reflections were not muddled. Each interview was conducted away from the main classroom to reduce distraction and allow the pupil to talk more freely. Interviews were usually conducted after mathematics lessons to give a focus for general discussion and examples within the interview. Pupils were withdrawn from other lessons with the permission of their class-teacher rather than missing break-times in order to ensure the interview was not seen as a punishment. Each interview was audio-recorded. Following the interviews, the completed tasks were collated and labelled and fieldnotes written to give contextualization to the interview transcript.

4.7.3 Pupil group-interviews

Items for the group-interviews were developed in three ways: from items that had previously been used in MRes individual interviews, as extensions to questions in the individual pupil interviews, and to address gaps not addressed by other research methods. Interviews were semi-structured and developed as group conversations around previously determined themes on an interview schedule (see Appendix K). The schedule for the pupil group-interviews was designed to approach similar constructs to the individual interviews but from a group perspective. These questions were designed to encompass Spradley's (1979) descriptive, structural and contrast question types, giving a context to the interview but also opening it out at an early stage to the pupils' voices, and allowing them to be comfortable with discussing such issues together. Some tasks were intentionally similar to those in the individual interviews to allow for triangulation.

Following piloting, it was decided that, particularly with younger pupils, group tasks were important to elicit discussion and ensure pupil focus. The intention was to introduce a 'Draw a Mathematician' task to probe ideas of being good at maths. This task comes from science education (Chambers, 1983; Thomas, Pedersen, & Finson, 2001) and has been used in mathematics education (Picker & Berry, 2000), but piloting suggested it was less successful in group-interviews, being time-consuming and difficult for pupils to share/organise. As such, this instrument was not used. The tasks that were used – classroom organisation and maths task cards (year 4) – are explained in Appendix K.

Groups were made up of the three focal-pupils in each set or class. There was a concern, particularly with the Year 4 mixed-ability pupils, that this would strengthen conceptions of ability and make it difficult for some of these pupils to talk together in the interview, but this proved to be unfounded. Each group of focal-pupils was interviewed twice during the research period, once as a group-interview and secondly as a follow-up group-interview. The follow-up interviews were developed during the research period to address any gaps in the data collection and begin to involve the pupils in the analysis process. During follow-up interviews, an interview schedule was not used in order to allow more flexibility for pupils' talk. Instead, tasks were introduced to provide some consistency between interviews. These tasks are discussed in Appendix K.

As with the individual interviews, each interview was conducted outside of the mathematics lessons and in as quiet a location as possible. Each interview was audio-recorded and notes were written about key things said by each pupil in order to ensure words within the transcription were correctly attributed to each pupil. The task items were photographed or scanned allowing data from these be inputted into the transcripts.

4.7.4 Teacher Personal Construct interviews

The teacher interviews were conducted at the end of the research period. This allowed me to develop the interview schedule over the research period, responding to the key issues emerging. The interviews were designed to allow a degree of comparison with pupil data as well as exploring the teachers' own understandings of ability.

The interview schedule is shown in Appendix L. I began by introducing the same line I had used in the individual pupil interviews. The teachers were familiar with this line as it was included in the attitudinal questionnaires they had administered. I asked the teachers to position each focal-pupil on the line and then used PCT questioning to elicit teachers' constructs. I then extended the semi-structured interview into a more open conversation being led by the teachers' to explore how they understood and worked with ability in their classes or sets. Within this conversation I covered two broad themes: assessment and setting/class placement.

I piloted the interview with one teacher at Parkview who left the school just before the end of the research period. This gave me an opportunity to assess the quality of data that would be produced and how much could be covered in 30 minutes. Piloting suggested the need to contract some of the areas and allow the teachers to talk more. I also clarified the instructions given when administering the PCT task to ensure this was done in a consistent manner.

The teacher interviews were conducted individually in the work or quieter areas of the staffrooms during lesson times when the staffrooms were almost empty. Other staff were aware of what I was doing and so we were given space and privacy to talk. Each interview lasted for approximately 30 minutes, although some, particularly at Parkview, lasted considerably longer where some staff appreciated the opportunity to talk about some of these issues. At Parkview interviews were conducted during teachers' PPA time and at Avenue cover was provided for an afternoon to allow all teachers to spend time away from the classroom. These arrangements ensured that the teachers felt comfortable leaving their classrooms and that we were not disturbed during the interview. Interviews were audio recorded and fieldnotes written immediately afterwards to add contextualisation.

4.7.5 Interview transcription

I transcribed recordings/field-notes as soon as possible after the interviews. This ensured that the data did not become clouded by subsequent data-collection. When pupils had completed tasks during the interviews, I included a digital image of these with their transcripts. Teachers' transcripts were returned to them and they were invited to amend these. No teacher chose to make any changes. When transcribing the audio recordings, I focussed on the words only rather than producing a conversation analysis style transcript with pauses and hesitations included (see transcript examples in Appendix M). This is justifiable in terms of my research questions and the types of analysis I conducted. Further, as Jackson (2000) notes, putting in each hesitation potentially breaks up the conversation and produces an inarticulate portrayal of the participants. The original recordings were retained for the duration of the research so I could return to these where clarification was required. The completed transcripts were imported into NVivo for analysis.

4.8 Qualitative Data Coding and Analysis, and Reporting

My data coding and analysis processes drew on multiple commentators, with developments arising from my MRes study. This study produced vast amounts of qualitative data, hence I used Brewer's (2000) analysis and interpretation distinction strategy. This ensures that all data is included in the 'bringing order' stage, whilst allowing for a selective in-depth analysis.

Each transcript was imported into a single NVivo project allowing consistent coding and analysis. Sets were created to provide manageability and allow use of NVivo analysis and comparison tools. Following this, each transcript was open-coded. An example of this, and the subsequent analysis processes discussed below, is given in Appendix N. Open-coding draws on constructivist grounded theory (Charmaz, 2005) which Oliver (2011) asserts to be highly compatible with critical realism; both have the same concerns, grounded-theory is particularly adaptable, and it is suggested that critical realism can adopt any method (Scott, 2005). My coding was perhaps more 'ad-hoc' (Kvale, 1996, p. 192), derived from a messy intertwining of 'theory', 'vernacular' and the 'interviewees' own idioms', not on any strict line-by-line or paragraph-by-paragraph basis, but through a perusal of the entire document and a searching for the similarities and differences that reveal themselves on immersion in the data (Strauss & Corbin, 1998, p. 120).

During coding, code descriptions and properties were written and codes were regularly cleaned. These processes ensured the justification of coding and made the coding more manageable. Cleaned codes were then structured into trees, and these trees were developed and clarified, using, amongst other tools, tree node coding charts within NVivo for each parent node. Having completed and justified these trees I had a complete coding list (with trees expanded) with a description for each node and each node attached to various data extracts.

I was then able to explore issues of rigour. Some aspects of this had already been covered in checking for redundant nodes and justifying my choices, but it was important to know how reliable the coding list was. I recoded a 5% random selection of transcripts using the coding lists and descriptions. These were compared with the original coding and suggested a high level of agreement. 88% of the coding matched and where a mismatch occurred this was usually where text was coded in one instance and not the other, rather than where different codes were applied to the same text. Further, my coding – both code production and application – was subject to scrutiny by other researchers in qualitative methods workshops. Agreement in the use and application of codes provided a proxy for the validity of the themes drawn from the data (Kurasaki, 2000).

Having developed the coding trees I explored how these themes fitted together and the relationships between each. This process resembles Strauss and Corbin's (1998, p. 124) axial coding, reassembling 'fractured' open-coded data, and developing a more complete explanation of the stories the data might tell. The strength of trees and nodes and the most salient concepts were identified through scree plots. NVivo code-by-code matrix queries then showed the extent to which data had been attributed to every possible pair of codes. Attribute-by-code matrices additionally showed the strength to which each level of attribute related to each node. The trees, scree plots and matrices began to give an indication of where potentially important areas lay in the data and of possible relationships. I used mapping and modelling software to axial code across the dataset and links to other data, i.e. questionnaire analysis, were added. On completion, the axial coding gave an overview of how the codes and their structuring trees were linked.

4.9 Data selection and Reporting

Major themes in relation to the research questions began to emerge from the axial coding. Extended memos resembling Spradley's (1979, p. 201) 'summary overview' were written and the data analysis was developed into coherent sections. With each section I drew together the various strands of data related to that theme from all research instruments. The quantitative and qualitative data were carefully linked, as Bryman (2007) calls for, using methodological triangulation (Denzin, 1997) where the two data types were compared to determine if there was convergence, difference, or some combination.

Having drawn out the themes, qualitative data were imported into the data writing to illustrate the discussion. These extracts were selected carefully; whilst they sometimes resembled critical incidents, they were also cases that illustrated, generally, what was happening rather than being one-off incidents. With each area, there were often multiple data extracts to choose from. In each case the choice was made based on the extract which best illustrated the discussion whilst at the same time being representative of the wider dataset. Selecting data extracts in this way and being clear about how they were selected increased the validity of the analysis.

Issues of validity, as well as of reliability and rigour, have been discussed at various points within, and prior to, this chapter. These concerns have run throughout the processes outlined. Two issues important to all aspects of this process are those of the impact of the theoretical framework and of the influences of the researcher. These issues were discussed in Chapter 2 and when considered in relation and in addition to the methods for bringing about validity and reliability outlined within this chapter represent a process of systematic data enquiry (Hammersley & Atkinson, 1983) which is none the less free to explore the issues arising and avoids issues of over-defensiveness (Silverman, 2005) which may result in a less readable or authentic analysis and discussion.

Having set out how the research was conducted and the data analysed, the following chapter introduces the two schools where the research was conducted. This gives a sense of the schools, their teachers and pupils and grounds the data presented in chapters 6 – 11. It also allows the reader to make comparisons with their schools and experiences and strengthens the claims make for generalizability in Chapter 12.

5 Avenue Primary, Parkview Primary and the Focal-Pupils

5.1 Introduction to the Schools and Pupils

Avenue and Parkview Primary schools are both located in the boroughs of a large city on the outskirts of local town centres. Avenue is situated within an area of affluent owner-occupied housing whilst Parkview serves a diverse area of owner-occupied and council-owned properties. Both schools are within walking distance of large parks, a river environment and other green spaces with Avenue additionally having access to common land, shared playing fields and areas managed by the National Trust. Both schools are 3 – 11 mixed mainstream primary schools with above average numbers of pupils on roll.[8] They each have a higher than average intake of pupils from minority ethnic backgrounds. At Avenue the number of pupils with English as an additional language (EAL) is above average, whilst as Parkview the number is below average.

The socioeconomic status, based on free school meal (FSM) eligibility, of the schools is substantially different, with an above average number of pupils – approximately a third – at Parkview eligible for FSM, compared with less than 10% at Avenue. Both schools have Designated Special Provision (DSP) for pupils with Special Educational Needs (SEN); Parkview for deaf and hearing-impaired children, and Avenue in a newly developed resource for pupils with High Functioning Autistic Spectrum Disorders (ASD). In external assessment, 90% of Avenue pupils achieved level 4 or above compared with 76% at Parkview. There is less difference in the Contextual Value Added (CVA) scores as a measure of pupil progress across Key Stage Two with Avenue having a CVA score of 101.1, compared with Parkview's CVA score of 99.9 (Department for Education, 2008).

In this chapter I describe each school in greater detail to contextualise the study. I describe the school background, demographics and my relationship with the schools. I also discuss the teachers, their approach to teaching mathematics and the classroom organisation of the schools with respect to ability-grouping. I also provide a brief introduction to the focal-pupils.

[8] The national average for English 3 – 11 Primary Schools was 238 pupils in 2009.

5.2 Avenue Primary School

Avenue is an over-subscribed mixed 3 – 11 primary school serving a limited catchment area. It is surrounded by parkland at the end of a long road of detached owner-occupied properties. The school is located in a popular commuter area, with many parents in professional occupations. Avenue is a large three-form entry primary school and Early Years Foundation Stage provider with just under 700 pupils on roll. The school originally consisted of separate infant and junior schools on one site each with their own staff and senior management teams. The two schools amalgamated in the September I began my research to create one large primary school under one head teacher and her senior management team. During the year I was there they began the development of specialist provision for pupils with High Functioning Autistic Spectrum Disorders and Avenue is now a designated provider of mainstream education within the borough for pupils with ASD.

The school has exceptional facilities for a state primary school. In addition to extensive outdoor areas, some tarmaced, some grassed, and equipped with play equipment, the school also has shared use of large adjoining playing fields. Further, the school has its own heated indoor swimming pool and all pupils have swimming lessons. The school has specialist teaching rooms for special needs and behavioural support, art and music.

When I arrived at Avenue in September it was still undergoing amalgamation and, in parts, resembled a building site. Despite the dust and building noise there was an air of professionalism, order and calm about the school. The large reception area had displays of awards and trophies won by the school and its pupils, certificates hung in heavy frames and, emphasising the traditional nature of the school, ranked photographs showing the whole-school and various sporting teams. I was greeted in a professional manner, given my own badge and referred to by staff and pupils as ‘Miss Marks’. I was introduced as a teacher and PhD researcher from King’s College and pupils were told they were privileged to have me working with them. I was given free access to much of the school, including the staffrooms, where a number of staff members spent time freely talking to me. My access to classrooms was limited to observations of mathematics lessons, reflecting in part the closed door and traditional nature of teaching at Avenue. This traditional ethos was also sensed in the behaviour of pupils, both in lessons and when walking around the school corridors where pupils walked quietly, in lines and were often picked up by staff for minor misdemeanours.

Avenue holds a strong position locally, obtaining outstanding Ofsted reports in all areas. The traditional and competitive ethos of the school is intensified by being located in a borough with a high proportion of well renowned academically selective and over-subscribed state grammar schools. Secondary school selection tests result in many parents seeking out advantages included paying for private tuition to secure a coveted place at these schools.

5.2.1 Avenue teachers

A new head-teacher took over leadership of Avenue during the year I spent there. The original and new head-teachers were both non-teaching, with their role principally managerial and business orientated. Both were seen walking around the school but there was little interaction between them and staff or pupils. Teachers talked about discussion with other members of the senior management team, but the head-teacher was rarely mentioned. The senior management team was responsible for the everyday running of the school and all my contact was with a member of this team.

Avenue has 35 teachers and 40 teaching assistants (TAs). Many staff have been at the school for a substantial proportion of their teaching careers although these are balanced by a smaller proportion of younger teachers. The majority of teachers have their own class for most of the day but also offer a specialism or additional area of responsibility. The school employs non-class based teachers allowing for the creation of more ability sets than classes, specialist teachers in art, French and music, and specialist teachers of dyslexic and autistic pupils.

When I started working at the school the Key Stage Two, or old Junior School, teachers and support staff used a small staffroom within their old buildings and what they saw as their half of the school. Despite being cramped, this facility was well used and you could often hear laughter and heated debate emerging from the room as you approached. During my first term, this staffroom was closed and all teachers across the school were expected to use a new integrated staffroom built to conjoin both halves of the school. The vision was of greater collaboration between Key Stages although this was never realised partly due to staggered break-times. The new staffroom appeared well-designed with work and discussion areas, computing facilities, an extensive kitchen area and even table-football. However, during the year I spent at Avenue, I never counted more than a handful of staff in the new staffroom at any one time. Key Stage Two staff would instead be found in their classrooms or even in the old staffroom which was being dismantled around them.

I spent the year working with the top and bottom mathematics sets in both Years 4 and 6. In addition to the Mathematics subject leader this involved six teachers as outlined in Table 4. Additionally, the quantitative aspects of my study involved brief contact with the other Year 4 and 6 set teachers, although this was predominantly for administrative reasons.

Teacher Pseudonym	Mathematics Set Taught	Additional Responsibilities
Mr Fuller	Year 6, Set 2	Assistant headteacher and mathematics subject leader
*Miss Gundry	Year 6, Set 1	Year 6 class-teacher, Senior Management Team (SMT), Science subject leader
Mr Hockins	Year 6, Set 4, term 1	Year 4 class-teacher, ICT subject leader
*Mr Leverton	Year 6, Set 4, terms 2 & 3	Floating cover teacher
*Mr Iverson	Year 4, Set 1	Deputy headteacher, leader of KS2 and assessment coordinator
*Mrs Jerrett	Year 4, Set 4	Year 4 class-teacher, SMT, EAL coordinator

Table 4: Avenue teachers (*denotes focal-teachers)

Mr Fuller was my main point of contact and had been leading mathematics at the school for many years. In teaching Set 2 he was not a focal-teacher but he was fully involved in the study, greeting me each morning and doing everything he could to help with my research. He was not a strong advocate for ability-grouping but saw it as necessary given school, curriculum and particularly parental demands. As the mathematics subject leader he talked about wanting to move set teachers out of the comfort zones they had settled into. He provided INSET on mathematics teaching and activities designed for a wide attainment range. Further attempting to push mixed-ability teaching, Mr Fuller supported the Primary Cognitive Acceleration in Mathematics Education (P-CAME) materials and aimed to include these regularly in Year 6 mathematics lessons. However, such lessons were infrequent, used as a last resort when forced by staffing issues. In contrast to Mr Fuller, many Avenue teachers were supportive (in practice, if not ideologically) of ability-grouping, seeing their role to be to increase attainment as exemplified particularly by external assessment:

> "All of my children that I had kept, their marks were much improved and the children who she took out were much improved as well, so I am a big fan of setting."
>
> (Miss Gundry, Avenue, Y6, S1, 16.07.08, lines 135-137)[9]

5.2.2 Classroom organisation and mathematics teaching at Avenue

Each year-group at Avenue is divided into three classes of 30 pupils. From Year 2 (ages 6 – 7), for the majority of mathematics lessons, these classes are regrouped within years to form four unequal mathematics sets. Pupils are not ability-grouped for other subjects. Pupils are assigned to mathematics groups on the basis of attainment tests and from Year 2 to the end of Year 6 there is little inter-set movement. Set 1 and 2 pupils are expected, by the end of year 6, to achieve or exceed the government targets in national testing. Set 3 pupils, who are referred to by teachers as the Cusp group, are expected to achieve these targets with additional input. Set 4 pupils are not expected to achieve these targets. Some of these pupils are dis-applied from national testing.

Teachers are assigned to sets on the basis of experience and matching of personality to perceived group needs. As pupils are split into more sets than there are classes, additional teachers are required. These may be non-class-based members of senior management, floating teachers or Higher Level Teaching Assistants. All sets keep the same teacher and that teacher usually teaches the same set for multiple years. The only exception is with Year 6, Set 4. These pupils began with a year 4 teacher. In the second term, this teacher was no longer available and the set size was reduced with teaching split between a floating teacher (Mr Leverton) and a Higher Level Teaching Assistant.

Teaching broadly follows the requirements of the National Curriculum and Primary Framework with one hour of mathematics every day. Teachers have a degree of autonomy in how they deliver this curriculum. Most classrooms are arranged in mixed horseshoe and row arrangements, but the focus is on pupils facing the front. Usually teachers teach from

[9] Throughout the thesis the following data-labelling conventions are used:

Individual interviews:	Name, School, Year, Set/Class, Attainment label (for pupils): HA=High Attainer, MA=Middle-attainer, LA=Low Attainer, Date of interview, Transcript line numbers
Group Interviews:	School, Year, Set/Class, Date of interview, Transcript line numbers
Observations/field notes:	School, Year (if applicable), Set/Class (if applicable), Date of observation/notes

the front of the classroom with pupils working individually through repeated examples. Pupils generally did not ask questions or participate in discussion unless initiated by the teacher.

Set 4 pupils usually worked with worksheets although whilst Year 4 pupils wrote directly on these, Year 6 pupils were often required to copy them into their books. Year 4, Set 1 pupils nearly always worked through teacher questions handwritten on the white board. Year 6 Set 1 pupils used a combination of interactive white board questions, SAT revision books and examples from a Year 7 textbook. In all cases they were required to write these out in their exercise books. Games and collaborative activities were rarely used. Where these were used, they usually formed 'starter' activities prior to transmission teaching and individual work. There was a vast difference between the curriculum content available to pupils in different sets with no collaboration between set-teachers. Within Year 6, Set 1, SATs preparation dominated lessons whilst in Set 4 a miscellany of content was introduced, much focussing on basic number fact acquisition.

5.3 Parkview Primary School

Parkview is also a mixed 3 – 11 primary school, although it serves a wider, more diverse, catchment area. It is situated in an area of mixed housing at the edge of an historic town centre. The town is a popular residential and commuter area and pupils come to the school from quite opposing backgrounds. Some come from working-class backgrounds and live on the local housing estates whilst others come from affluent middle-class backgrounds and large detached properties further away from the school. Parkview is almost twice the average primary school size with nearly 450 pupils on roll. The school has Designated Special Provision (DSP) for deaf and hearing-impaired children, resulting in a higher than average number of pupils with Special Educational Needs in the school. The school has a fully inclusive approach and whilst the centre for the deaf offers placements for approximately 25 children, these pupils are integrated into mainstream classrooms. The school is housed within an old building and bounded by a railway, housing and roads on all sides. The outdoor area is tarmaced whilst teachers are constrained inside by a building design not always fit for 21st Century teaching; for example it was impossible in one of the year 6 classrooms for all pupils to clearly see the interactive white board.

During my research I was given free access to the school, its classrooms and staffroom. I was free to come and go as I wanted and everyone seemed keen to help me. Most teachers had an open door policy and some were happy for me to come and go from their classrooms as well as allowing me to observe other lessons. This relaxed atmosphere to my presence in school carried over into the status given to me and my research. I was called 'Rachel' by staff and pupils and introduced to the pupils as a student. The pupils seemed to be at ease in my company and that of the numerous adults they had in school. Pinpointing the ethos of Parkview is not simple. The old building lent itself to a feeling of austerity yet this was punctured by the sounds of pupils and through the display of bright artwork. Although pupils were encouraged to walk around the school quietly, this was not always observed; combined with the tight enclosed stairways and echoing corridors this meant the school rarely seemed quiet. There were often pupils moving around the school at all times of the day either as part of a class-group or for individual lessons and it was not unusual for pupils to come and go from lessons or for lessons to be disturbed, sometimes repeatedly, by pupils with requests from other school staff.

Parkview has, until 2009 achieved above the Local Authority average in aggregated KS2 test results with its scores roughly in line with the average for England. It has always scored slightly lower in mathematics than in other subjects. Their CVA scores indicate that pupils make progress across KS2 in line with expectations. Having such a diverse intake, the pupils move on to numerous secondary schools. Approximately a third of Parkview pupils transfer to a local state comprehensive. Other pupils move to various state and private secondary schools. Many seek a place in neighbouring boroughs at a variety of selective schools. These are heavily oversubscribed and the distance Parkview Pupils are applying from makes a successful application more unlikely. This puts immense pressure on pupils and their parents with many pupils undergoing tutoring with the specific aim of securing a grammar school place.

5.3.1 Parkview teachers

Miss Attwood, the head-teacher at Parkview, although not class-based, is a prominent figure within the school, often seen in the staffroom and interacting with staff and pupils. Her office door is usually physically and metaphorically open and there are often staff talking to her or pupils in her office who have usually been sent for behavioural reasons. The head-teacher was my main point of contact at Parkview and devoted much time to supporting the implementation of my study. It would not be clear to a visitor to Parkview where the school hierarchy lies and which members of the staff are members of the SMT, as all staff, teaching and non-teaching appear to interact on an equal basis. Parkview has 19 mainstream teachers and a number of specialist teaching staff within the DSP. There are also a large number of teaching assistants working within and between the mainstream and specialist unit classes. A number of teachers are younger teachers although they are also balanced by a proportion of more experienced teachers. Most teachers have their own class which they teach for all subjects, although three classes are taught by pairs of job-share teachers.

The school has a small but well used staffroom. Although not set out with specific working areas, many staff could often be found working here in their non-contact time in addition to staff using the room for social purposes. Staff all seemed to interact regardless of role, stage or subject taught. The majority of the larger school equipment – the photocopier, laminators, paper supplies – are housed within the staffroom, adding to the extensive use of the room particularly amongst TAs who used the space to prepare resources. Staff meetings, to which I was invited, were held within the staffroom, and clearly illustrated the space issues facing the school as staff squeezed onto seats or took up a position in a corner of the room or within the kitchen area. When not observing classes or interviewing pupils or teachers, I spent much of my time in the staffroom where staff appeared comfortable in my presence.

Of the 19 mainstream teachers, I spent the year working with the Year 4 and Year 6 teachers and their classes/sets and also with the head-teacher. As there were only two classes in each year-group, my research design did not involve working with any other Parkview teachers. The teachers worked with are outlined in Table 5. Although the head-teacher was my initial point of contact, contact was established individually and research timetables worked out with each member of staff, resulting in staff feeling in control of the research.

Teacher Pseudonym	Mathematics Class / Set Taught	Additional Notes
Miss Attwood	Year 6, Set 1 (B)	Headteacher, team-taught Set 1 or took out a group from set (~ ⅓) to form set B
Miss Barton	Year 6, Set 1 (A)	Year 6 class-teacher
Mrs Clifton	Year 6, Set 2	Year 6 class-teacher, Mathematics co-ordinator
Mr Donaldson	Year 4 mixed-ability	Taught own Year 4 class for Mathematics
Mrs Ellery	Year 4 mixed-ability	Taught own Year 4 class for Mathematics

Table 5: Parkview teachers

Teachers at Parkview appeared to have substantial freedom regarding their classroom organisation and teaching methods. Although planning was done jointly within year-groups, the same lesson was often delivered in two very different ways by the year-group teachers. In the following section I discuss in more detail the class, group and set organisation and mathematics teaching at Parkview.

5.3.2 Classroom organisation and mathematics teaching at Parkview

In the early stages of this study I produced a research design that seemed feasible; I would find two closely matched schools, one which set pupils for mathematics lessons and one which did not. I felt, as did others I sought advice from, that if I was to experience any difficulty in finding such schools it would be in finding a fully-set school. I could not have been more wrong. When discussing my research with others, particularly those not closely associated with primary education, they are often shocked to hear about setting in primary schools and the apparent move back towards a system similar to the streaming many of them experienced as pupils.

Parkview was the closest that could be found to a mixed-ability model within a multi-form entry school. In my initial contact with the school I was assured that, apart from Year 6, no form of ability-grouping was in place throughout the school and that the school was opposed to such classroom organisation. Prior to my research I spoke to the head-teacher to assess the suitability of the school for the study. This meeting began well; Miss Attwood talked at length about her beliefs about mixed-ability models, she explained how mixed-ability teaching was applied throughout the school and her disappointment at the perceived need for setting in Year 6 due to external assessment pressures. In order to assess the extent of ability free teaching I asked about grouping in classes and was assured that ability-grouping was not used. Before I could probe further about the classroom organisation methods used, we were disturbed by shouting and crying carrying down the corridor. This was followed by the appearance of Adina, a small 7 year-old girl at the head-teacher's door. Adina was well known to all staff and often excluded from class, as on this occasion, for behavioural issues. Following her usual stance of taking a counselling rather than disciplinarian role, Miss Attwood brought Adina into the room with us, and had her sit with her. Miss Attwood explained to Adina who I was and involved her in our discussion. I returned to the previous question of classroom organisation, particularly in mathematics lessons; Miss Attwood began to reply talking about pupils being sat in mixed table groups, then turned to Adina and asked her if that was correct. "No Miss" came the answer, "Miss Mason makes us go and sit in our maths-groups, there's the green-table, the purple-table, the blue-table, the yellow-table and the red-table. The green-table are the best at doing maths, I'm on the red-table, but after break we go back to our normal tables." Miss Attwood was clearly taken aback by this, explaining to me that she was not aware that such ability-grouping was used. This lack of awareness made Parkview an interesting school to work with in understanding teachers' motivations for different classroom organisations and the unnoticed nature of this.

What actually happened at Parkview was that each year-group was split into two fairly equally sized classes for the majority of their day. These classes were split on a variety of factors common to primary schools including behavioural issues, friendship groupings and in the case of Parkview, SEN support needs. Up to and including Year 5, pupils remained in these mixed-ability classes for all lessons including mathematics. What happened within the classes was up to individual teachers and although mixed-ability grouping was encouraged by the head-teacher this was not always the reality experienced by the pupils. The two Year 4 classes I worked with exemplified these differences.

Mr Donaldson had inherited a class which in Year 3 had been ability-grouped for mathematics in much the same way as described by Adina. When I began working with this class he maintained such groupings as it was the way the pupils were used to working and he wanted to make the transition as smooth as possible. However, he was clear that this was not his preferred way of working, and during that first term he began to introduce a greater number of mathematics lessons where pupils were not moved from class-groups into maths groups. At first the pupils questioned this, often assuming that he had just forgotten, but by the start of the second term it was the norm for pupils to remain in class-groups. Although these groups were mixed-ability, they had been carefully constructed around notions of ability and achievement to allow higher achieving pupils to assist those who may struggle.

In contrast, Mrs Ellery, the other Year 4 teacher, imposed a rigid system of within-class ability-grouping for both mathematics and literacy, with tables labelled by colour. Pupils were aware of what these table colours meant, of the different work given to different tables, and of their place within this system. Pupils did not move groups except in the case of severe behavioural issues where they were withdrawn to a separate non-labelled table. At the beginning of each mathematics lesson, a considerable amount of time was given over to pupils moving from their class to their mathematics tables. During the second term working with this class, a student teacher took a number of lessons. He was free to organise the class as he wished, but under the guidance of Mrs Ellery maintained rigid ability-groupings. Not being set between classes, Year 4 teachers had more freedom to respond to pupils' needs. On some occasions lessons started later whilst teachers dealt with pastoral issues, whilst at other times mathematics lessons were continued beyond the usual 'numeracy hour' if this was felt appropriate.

The organisation for mathematics lessons in Year 6 was very different to the rest of the school. Against the wishes of the head-teacher, and a debated subject every year, Year 6 was set between classes. The two classes were regrouped into two mathematics sets: a larger top-set and a smaller bottom-set with no movement between sets. Although the sets were officially named as Set 1 and Set 2, the pupils, and occasionally the teachers, referred to them as the top and bottom sets. Set 1 was further split into Set 1A and Set 1B. The intention was that Miss Barton, a Year 6 teacher, would take Set 1A, whilst the head-teacher would take Set 1B. However, Miss Attwood's other commitments meant that she was rarely available during mathematics lessons and as a result Sets 1A and 1B were usually taught together as a large group by Miss Barton. Set 1 experienced mixed teaching formats. Often they were taught singularly by Miss Barton without TA support. On other occasions Miss Attwood would be present for all or part of the lesson but involved to varying extents. This resulted in either supportive or complementary teaching where she remained in the classroom as another adult or parallel teaching where she withdrew Set 1B as a separate group (see Villa, Thousand, & Nevin, 2008, for discussion of co-teaching distinctions).

Sets and classes (except Set 1B who were taught in any available space when withdrawn) were taught in the teachers' own classrooms and these were arranged as the teachers desired, but within the limitations imposed by the spaces and physical classroom layouts. In all classes, pupils were sat in medium-sized groups, usually with six pupils at each table and all either facing or perpendicular to the board at the front of the classroom.

Teaching followed the requirements of the National Curriculum and Primary Framework and was heavily influenced by the Numeracy Hour model with clear starter, main activity and usually plenary activities in each lesson although the coherence between these sections was not always clear. Starter activities usually took the form of whole-class games and, as with many aspects of the lessons, could become quite noisy, boisterous and competitive. During lessons there was generally a high-degree of interaction between the teacher and pupils although this was controlled by the teacher in addition to allowed and non-allowed peer interaction. The majority of lessons were taken from online Primary Framework resources and demonstrated via the Interactive White Board before pupils completed their own version of similar worksheets. IWB use was particularly strong in Year 6, Set 2 where the teacher brought up 'TestBase' questions, with the pupils repeatedly either practicing SATs style questions or being taught examination techniques. In Year 6, Set 1, questions were predominantly worksheet based reflecting the allowed individuality of the teachers who were still covering similar material.

5.4 The Focal-pupils

As highlighted in the research design I focused on three pupils from each class or set. These pupils were selected by the set or class-teacher to represent the attainment range of the group. Table 6 details the 24 focal-pupils of the study.

Name	**Girl/Boy**	**School**	**Year**	**Set or Class**	**Class position**	**Maths age Oct 2007**	**Test position**
Abbie	Girl	Parkview	6	1A	HA	13.6	HA
Ben	Boy	Parkview	6	1A	MA	11.4	MA
Catherine	Girl	Parkview	6	1B	LA	10.5	LA

Name	Girl/Boy	School	Year	Set or Class	Class position	Maths age Oct 2007	Test position
Delyth	Girl	Parkview	6	2	HA	8.7	MA
Emily	Girl	Parkview	6	2	MA	8.0	LA
Finn	Boy	Parkview	6	2	LA	9.4	HA
George	Boy	Parkview	4	Mr Donaldson's	HA	9.7	HA
Helen	Girl	Parkview	4	Mr Donaldson's	MA	8.3	MA
Ivy	Girl	Parkview	4	Mr Donaldson's	LA	4.6*	LA
Jessica	Girl	Parkview	4	Mrs Ellery's	HA	10.0	HA
Kelly	Girl	Parkview	4	Mrs Ellery's	MA	6.8	MA
Louise	Girl	Parkview	4	Mrs Ellery's	LA	5.7	LA
Megan	Girl	Avenue	6	1	HA	12.8	MA
Natalie	Girl	Avenue	6	1	MA	12.2	LA
Olivia	Girl	Avenue	6	1	LA	12.6	MA
Peter	Boy	Avenue	6	4	HA	8.7	HA
Rhiannon	Girl	Avenue	6	4	MA	8.7	HA
Samuel	Boy	Avenue	6	4	LA	7.7	LA
Thomas	Boy	Avenue	4	1	HA	11.1	HA
Uma	Girl	Avenue	4	1	MA	9.1	LA
Victoria	Girl	Avenue	4	1	LA	9.5	MA
Wynne	Girl	Avenue	4	4	HA	6.4	MA
Yolanda	Girl	Avenue	4	4	MA	7.1	HA
Zackary	Boy	Avenue	4	4	LA	4.9*	LA

Table 6: Focal-pupils – Shaded boxes indicate mismatched attainment test and teacher placement (*these pupils did not complete the test and age is based on attempted questions)

I left the selection of focal-pupils to the teachers, with the only instruction being to give me a high, middle and low-achieving pupil within their set/class. Teachers were free to interpret this statement, this being intentional as it gave further evidence of how they thought about their pupils. Although I was careful to avoid the language of ability, many teachers swapped attainment for ability or used the terms interchangeably.

One concern I had with allowing teacher choice of focal-pupils was that I might not be given a representative sample. As such I used the pupils' scores in the first administration of the attainment test to categorise every pupil into a high, middle or low-achiever with respect to the scores of their class/set. These positions are shown in Table 6 and are shaded to highlight any discrepancies with teacher labelling. Although the number of mismatches is high, particularly at Avenue, these results still indicate the focal pupils to have a range of attainment and as such it was decided to keep these focal-pupils as the teacher decisions could also reveal much about assumptions of ability. The discrepancies at Parkview were all in Year 6, Set 2 where all pupils were mislabelled according to the results of the attainment test. Mrs Clifton, who taught this set, relied heavily on her assessment records, making such misplacements more interesting as they begin to suggest the role of teacher judgement in assessment.

As I began the research I found it useful to write pen-portraits of each focal-pupil. These enabled me to think about how the pupils fitted into the population they represented and how they were unique. Below are the profiles of five pupils: Finn, Delyth, Megan, Sam and Zackary. These are pupils who were more different from the other focal-pupils and who feature strongly in the chapters that follow. These portraits provide important background that may help in interpreting the data. This is not to say that the other focal-pupils were identical; each brought their own characteristics, approaches to mathematics and conceptions of mathematical-ability. Overall they provided a broad understanding of how these primary school pupils were affected by and worked to understand discourses and practices of ability in primary mathematics. Other pupils beyond the originally selected focal-pupils also came to be important as I worked in these sets and classes during the year. With these and the focal-pupils not profiled below, I provide additional background information as necessary throughout the data chapters.

> *Finn (Parkview, Year 6, Set 2)*
> Finn exemplified the role of behavioural expectations in judgements of ability. He was a tall Afro-Caribbean boy who outwardly rejected many aspects of school. He wanted to be a footballer and his main topics of conversation were football, footballers and P.E. lessons. He did not enter into the discussions of his peers on school choice and secondary selection, stating when pushed that he was just going to the local school because that’s where his brothers went. Although Mrs Clifton regrouped the pupils by SATs scores within her set, Finn was usually asked to sit on a table by himself right next to the teacher. He had an infectious laugh and was considered by many to be the class clown; a reputation he regularly lived up to. Finn often took the brunt of the blame for misdemeanours in the set. Many of his peers were adept at setting him up before sitting back, watching him react, often explosively, and seeing him admonished for these behaviours. Mrs Clifton struggled to engage Finn in whole-class work in mathematics; he often emotionally and physically distanced himself in lessons, pushing his chair back away from his desk against the wall and refusing to engage with the lesson or speak in front of the class. However, on a one-to-one basis, either directly with me or when observed with a TA, Finn engaged in conversation and focussed, at least for a certain amount of time, on the task. He

> responded well to specific rather than general praise and it seemed that although he appeared not to have been listening during whole-class teaching, he was in fact taking in what had been said and could apply the material taught. His attainment test scores showed him to be one of the highest achievers in his set with his score overlapping the range of scores in the top set. However, his outward behaviour appeared to mediate judgements made of him and Finn was categorised as a low-achiever.

My observations of Finn and the sense I got of his approach to mathematics as I worked with him over the year sat in stark contrast to the image presented of him by the set-teacher. Mrs Clifton relied heavily on assessments, yet these were mediated by assumptions of behaviour and conformity to ways of being that were considered appropriate to the school environment. This was seen from a different perspective with Delyth, who was also misplaced by Mrs Clifton.

> *Delyth (Parkview, Year 6, Set 2)*
> When I first began working with Delyth I was told that she was the highest achiever in the group with quite a gap between her and the rest of the set. She had been kept in the lower set as she was said to lack confidence in her written work. My initial observations of Delyth showed her to fit this profile; she appeared confident, regularly contributing to class, putting her hand up and engaging in the mathematical discourse modelled by the teacher. However, as I worked with her a mismatch appeared. There were gaps in her written work and although she talked in an assured manner it became apparent that she was using stock phrases; for instance, when completing revision questions on shape categorisation she arbitrarily interjected phrases from earlier work on grid multiplication. Delyth was astute at playing at being a mathematician; she coped in lessons by engaging in pro-school behaviours, always sitting up straight with her arms folded, often putting up her hand and looking disdainfully at those who misbehaved. She repeated the teacher's phraseology, used the mathematical vocabulary on display around the classroom and was adept at working with Mrs Clifton's funnelling to provide the expected answers. When it came to written work, Delyth seemed to employ two strategies. Firstly she would answer the questions she could (or those that she could easily copy from a neighbour) earning her praise not only for the correct answers but also for employing a sensible approach that she could use in her SATs. Secondly, she was meticulous about her presentation; on a number of occasions her work was held up as an example to the class despite often being mathematically incorrect. Delyth's approach served her well in mathematics lessons earning her a reputation as a high-achieving student, yet her test results placed her towards the bottom of her year-group and it was only through careful observation that the underlying reasons became apparent.

Two-thirds of the Avenue focal-pupils were mislabelled according to the attainment test results. Despite this, the focal-pupils I worked with still represented the range of attainment in these sets. Mislabelling appeared to occur for similar reasons to that of Finn and Delyth, with, in general, pupils exhibiting non-conformist behaviours ranked lower and those able to perform pro-school behaviours assessed more favourably.

> *Megan (Avenue, Year 6, Set 1)*
> Megan was a particularly interesting girl to work with. All the staff, with the exception of Mr Fuller, talked about her as a gifted and talented mathematician who did not have to put in any effort to achieve. Other pupils spoke about her in other worldly terms; she did not fit their pre-conceived categories, academically fitting the 'Clever-Core' but behaviourally being outside of this, displaying very introverted behaviours and only joining in when directly questioned. It was these introverted and cautious behaviours that made her less mathematical in Mr Fuller's mind. Interviews and classroom observations suggested Megan was a high-achiever, who understood the material, but who was also a perfectionist, terrified of making a mistake in front of her set. As a result she tended to perform safe pro-school behaviours and only offered answers to questions where she was sure she would be correct. Gender played an important role in her positioning. Academically she was achieving in line with the Clever-Core boys but behaviourally she did not fit this extroverted and boisterous group. Behaviourally she aligned far more with the pro-school actions of the girls in her set, yet they saw her as somehow different because of her academic level and the singling out of this by the teachers. As such, Megan did not occupy a pre-constructed place within the group, with her initial high-achievement singling her out from the other pupils, this being reinforced by staff comment and praise. These actions in turn increased Megan's perfectionist behaviours. Over the course of the year, Megan gained only 0.5 years in her attainment test, placing her in the bottom third of her set in terms of gains.

In Megan's case, the beliefs and actions of the teachers, meant in a supportive manner, may have contributed to her lack of place, anxiety and lower gains. Ultimately, she was still a high-achiever, having a high starting point, and although the teachers' and pupils' actions impacted on her class behaviours she was still able to learn and achieve. Megan displayed a degree of resilience and although her coping methods, i.e. not joining in class discussions, may have been detrimental, she was able to find a satisfactory way of being in the class. This was not the case for all pupils who felt out of place, as demonstrated by Sam at the opposite end of the attainment spectrum.

> *Sam (Samuel) (Avenue, Year 6, Set 4)*
> I was warned initially by the Avenue teachers that although Sam would be very interesting for my study, he may not engage with me and may be very difficult to work with. However, Sam was one of the most receptive focal-pupils, keen to work on a one-to-one basis and to talk to me in interview. Despite this, it was clear why the teachers held these views, and in class his behaviours could be extremely challenging. Unlike

> Rhiannon and Peter who moved to Set 3, Sam stayed in Set 4 for the duration of the year and I was able to focus my attention on him. Not having a statement of SEN, Sam was not allocated individual support, but equally Mr Leverton often commented that he felt Set 4 was not right for Sam and that he would be better working on a one-to-one basis away from the rest of the class. The school often talked about Sam's home background and from these conversations there appeared to be a gulf between home and school expectations. Sam had an ambivalent relationship with school and looked for other group identities. His lack of willingness to work and low-attainment seemed to make him unpopular with the teachers, resulting in a repetition of negative attitudes towards him; Sam knew his placement academically and also knew that nothing was being done to help him improve. Socially and behaviourally, Sam had a difficult relationship with other pupils. Whilst he had one close friend in Set 4, Sam was a large child and his eruptive and occasionally aggressive behaviour distanced other pupils from him. Avenue had a strict behavioural policy, but, unlike other pupils, Sam would shout back at teachers. On three occasions he was observed self-excluding from mathematics lessons, walking out of the classroom. His behaviour seemed to mediate his teachers' expectations and Sam was aware that very little was expected of him. In the majority of mathematics lessons, Sam was given photocopied worksheets from Year 2 resource books and expected to work independently. Outwardly he appeared not to engage with these and disrupted other pupils. He was the lowest achiever in his set and over the course of the year made no gain in his attainment tests. At the end of Year 6, Sam was disapplied from the SATs.

Working with Sam was very different to working with other focal-pupils, bringing a number of ethical issues in addition to causing me to reflect on practices I had engaged in as a teacher. In addition to planned interviews, Sam often talked after lessons or when we were working together when he had walked out of lessons. Sam was very honest about his relationship with the teachers and his behaviours. Ethically, as well as methodologically, it would be difficult to use this material directly, but it gave me a more thorough understanding of Sam's approach to mathematics.

In both Finn and Sam's cases, the focus of their relationship with their teachers was behavioural and this infiltrated into assumptions about mathematical-ability. In the case of another focal-pupil, Zackary, also a low-achiever, the focus was not behavioural but based on assumptions about SEN. Again, lower expectations were applied with the assumption of supporting the pupil, but rather than raising academic outcomes they potentially increased behavioural issues.

> *Zackary (Avenue, Year 4, Set 4)*
> Zackary's first words to me were "I'm dyslexic Miss, that's why I can't do maths". His approach to tasks was inconsistent, and his dyslexia was

> often a stand-by phrase when he was struggling with something or wanted to do something other than the lesson task. This attitude was perpetuated by his set-teacher who also told me several times that he was dyslexic and "probably autistic too because he will not do the work as he's told". Zackary had a strong belief that some people were born able to do mathematics and some were born not able to do mathematics. Zackary was clear that he was someone who could not do mathematics. Given this belief, his approach in mathematics lessons was unexpected. Often he would appear to be daydreaming and not engaging with the lesson during whole-class work. In his individual work he would often misinterpret the task making it far harder than required, and his methods, although they worked, were elaborate and elongated. On some apparently simple repetitive tasks he refused to complete his work. At other times, he appeared fully engaged, increased the mathematical difficult and often asked for harder work, being fascinated by the possibilities of bigger numbers. Whilst other pupils followed the instructions and worked with numbers under 20 when asked to choose two numbers to add, Zackary did not get as far as the computation as he was still writing down his first choice of number: "Miss, how do you write 4 million?" Evaluation of observations suggested Zackary was more engaged when the tasks were either harder, open-ended or where he could circumvent the task requirements to make them more challenging. His lack of work at other times appeared to be his way of showing frustration and he would often mutter to himself that the work was too easy and that he wanted to use bigger numbers. Zackary's approach was difficult to understand: he categorised himself as someone who could not do mathematics yet seemed to relish mathematical challenge. Sometimes he refused to work, yet on another occasion he would not go to lunch because he wanted to finish the addition problem he had set himself.

In this and the previous chapters I have set out what this research is about and justified it in relation to the current literature. I have also explained the research design and methods as well as introducing here the context in which the research took place. The following six chapters present the data analysis, both quantitative and qualitative.

6 Quantitative Analysis and the Mixed-Methods Study

6.1 Introduction

The data analysis is presented in this and the following five chapters. This chapter focuses on the quantitative analysis, whilst the following chapters are predominantly concerned with the qualitative analysis. This chapter is not a complete representation of the quantitative analysis conducted in this study, and the predominant analysis presented in this thesis is the qualitative analysis of the following chapters. Instead, this chapter presents an overview of the key findings of the quantitative data within the study, arguing for the study as a whole to be considered as a mixed-methods study where the quantitative data acts in a supportive, background role to the overt qualitative data presentation.

The quantitative data come from the attainment tests and questionnaires, with relationships examined within the variables of: attainment, perceived ability, enjoyment, beliefs and orientations. Analysis was conducted at different levels including: the full data set, school, year-group and set placement. The methods of statistical analysis were outlined in Chapter 4 and resulted in extensive outputs. Quantitative and qualitative analyses were conducted concurrently with the data types integrated in drawing conclusions from the research.

6.1.1 Justification of a mixed-methods study

I noted in section 4.1 that the mixed-methods approach to data collection and analysis was still relatively uncommon in mathematics education. Dependent on definitions and expectations of a mixed-methods study, it may be argued that this research is not truly mixed-methods particularly given the extensive space given to qualitative analysis over quantitative analysis and the relatively limited integration of data types within the key thesis findings. However, I would argue for this to be considered as a mixed-methods study; the quantitative analysis played a key supportive role in the identification of apparent regularities in the data and the weaker statistical findings, although not fully reported here due to space constraints, are themselves important in understanding more broadly the findings of this research.

This thesis may not be considered mixed-methods due to the disproportionate spaces given to representation of quantitative and qualitative analysis, although additional quantitative analysis was carried out beyond that within this thesis. Additionally, due to a limited uptake of Critical Realism, it is not yet clear what CR, and hence a CR mixed-methods approach, might generally look like in educational studies. CR is concerned with *potential* explanations for *apparent* regularities (Bhaskar, 1975). From this, it seems feasible that a study might take an unbalanced approach to the use and integration of quantitative and qualitative methods, with, as in this study, qualitative data led explanations building on and enhancing the quantitative data concerned with the identification of apparent regularities. As such I would argue for this research to be considered as a mixed-methods study with the powerful research methods supporting each other, allowing the study to draw strong, well-justified conclusions.

6.2 Key Quantitative Findings

In this section I set out three key findings arising from the statistical analysis. These findings represent the strongest quantitative findings from the study. Further, each resonate with the existing literature and as such are important in providing strong links with current research. These findings are discussed first and foremost from a quantitative perspective. Within the discussion of each finding I indicate where the quantitative data is triangulated and extended within the subsequent chapters. Further, I integrate these quantitative findings into the key outcomes of the research discussed in Chapter 12.

Quantitative data were collected twice as pre- and post-tests in October 2007 and July 2008. Much of the analysis presented here focuses on the measurement of these variables at one point in time. For these analyses I have used the post-test data. This data relates to pupils' experiences during the year of the study and higher completion rates provide a larger dataset for the analysis.

6.2.1 Set placement

The attainment test results provide raw scores and gains data. The schools are known, from Government data, to differ in attainment, hence gains are more meaningful when looking across the schools. Throughout the analysis, year-groups were considered separately as they took different tiers of the LNRP test. Analysis focused on two areas:

- descriptive and inferential statistics of gains allowing comparison of LNRP and CVA data
- descriptive statistics of set scores investigating set allocation and impact

As expected, Avenue test scores were significantly higher than Parkview in Year 4, $t(103) = 3.83$, $p < 0.001$, and in Year 6, $t(117) = 2.61$, $p = 0.01$. Pupil gains in Year 4 were not significantly different between schools, $t(103) = 1.68$, $p = 0.10$. In Year 6 gains differences between schools were significant, $t(117) = 2.88$, $p = 0.01$. These results suggest that, in comparison to the LNRP samples, Parkview underperformed in the 2007-2008 academic year, whilst Avenue was average in terms of gains. These results are consistent with the CVA scores discussed in section 5.1.

Particularly interesting data emerged when looking at the impact of set placement on gains. Here I report analysis of data from Avenue, Year 6. This focus allowed consideration of the impact of rigid setting on pupils. The data in Table 7 show the pre- and post-test maths ages and gains for pupils in each set who completed both tests and did not change sets.

		Maths Age 2007			Maths Age 2008			Maths Age Gain (years)		
Set	**n**	**Mean**	**S.E.**	**s.d.**	**Mean**	**S.E.**	**s.d.**	**Mean**	**S.E.**	**s.d.**
1	25	12.67	0.12	0.59	13.50	0.07	0.37	0.83	0.10	0.49
2	24	10.82	0.12	0.60	11.89	0.13	0.65	1.07	0.09	0.46
3	13	9.76	0.17	0.60	11.11	0.16	0.59	1.36	0.19	0.69
4	9	8.31	0.15	0.46	8.89	0.30	0.91	0.59	0.22	0.65

Table 7: Maths ages and gains – Avenue Year 6

A boxplot of the pre-test results (Figure 4) is particularly interesting in terms of the existing literature.

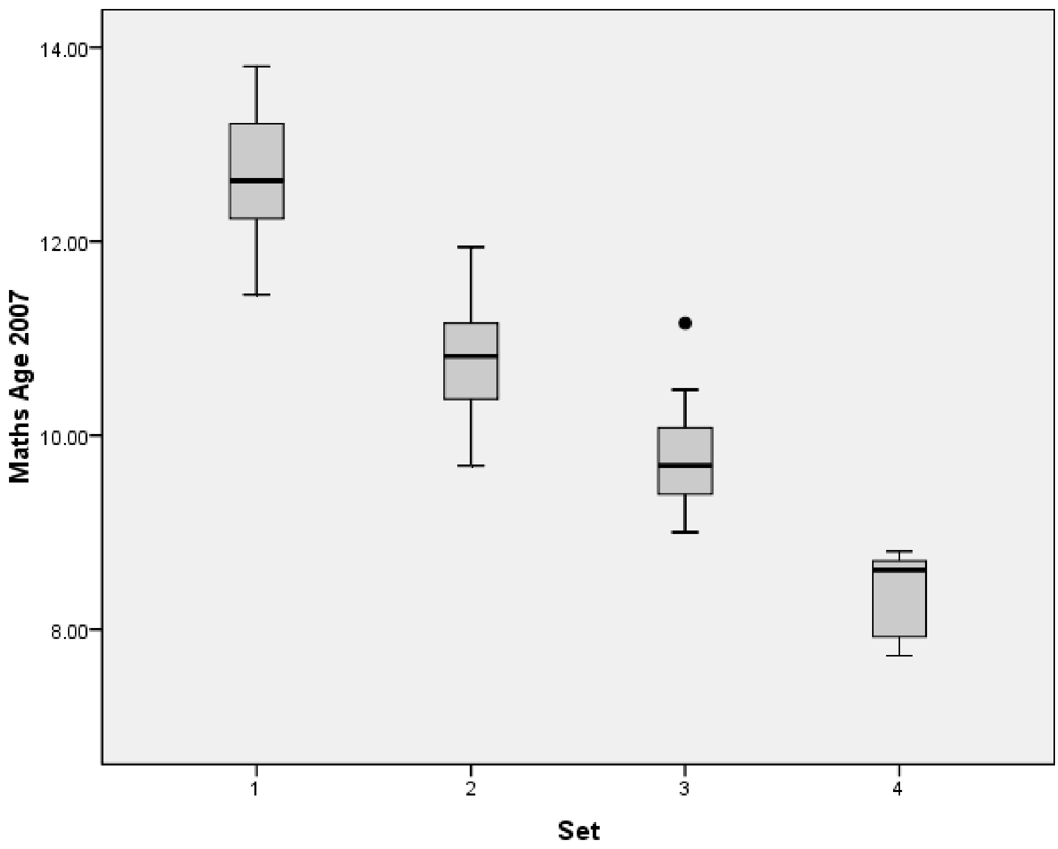


Figure 4: Boxplot of pre-test maths ages - Avenue Year 6

As is clear from this boxplot, there is considerable overlap between the pre-test maths ages of pupils across the sets. Overlaps exist between all adjacent sets suggesting that pupils assigned to different sets may be performing at the same level mathematically. Similar patterns were found for Year 4 at Avenue and Year 6 at Parkview. This calls into question the methods used by the schools for set allocation. It is also an important basis for considering the different mathematical learning opportunities provided to pupils assigned to different sets and the justification for this where pupils have identical or very similar initial attainment levels.

There are resonances between the boxplot above in Figure 4 and McIntyre and Ireson's (2002) within-class grouping results outlined previously in Section 3.3.1. The results from their study, looking at the attainment of pupils in within-class groups, are reproduced below in Figure 5.

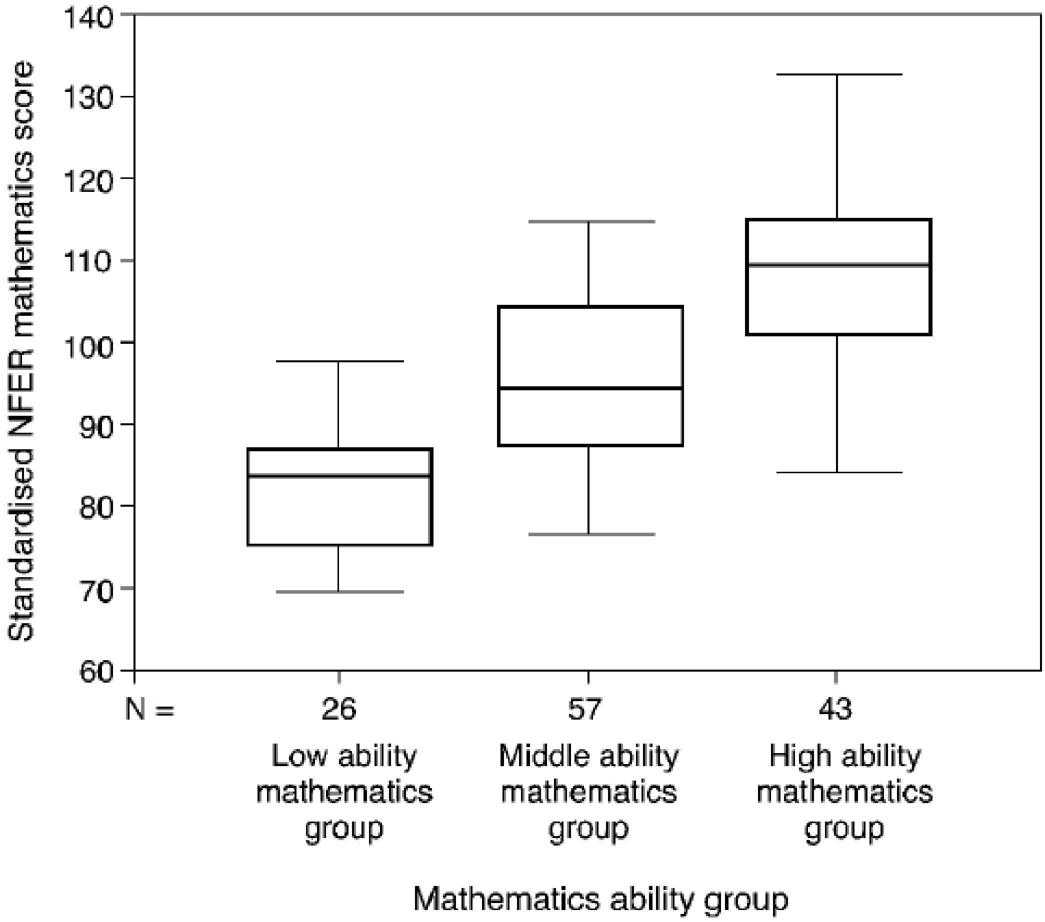


Figure 5: McIntyre and Ireson's (2002, p.255) within-class grouping results

Whilst McIntyre and Ireson's (2002) study examined a different form of ability-grouping – within-class grouping – the results are similar. In both cases, the lack of clear demarcations between the attainment ranges of each group/set suggest that setting and grouping decisions are not being based purely on attainment test results, the impact being that many pupils are being allocated to particular sets when their scores could equally place them in a different group with its incumbent different experiences and expectations. The results from the present study, highlighted in Figure 4, are therefore particularly significant in extending and adding weight to the current literature on set/group misplacement. Understanding the extent of this occurrence is important when considering the differential teaching and learning experiences allocated to each set/group. The impact of these differential experiences will be considered further quantitatively in the following section. Further, the issues raised in this present section are explored further through the qualitative analysis presented in the following chapters: in chapter 7, which explores productions of ability, judgements that may be brought into setting decisions, on top of attainment results, are considered, whilst chapter 10 examines aspects of reproductive identity work which may underlie these judgements.

The key finding of this section:

> *There is considerable overlap between the initial attainment test scores of pupils in different sets. This may suggest that factors other than attainment are implicated in decisions over set placement.*

6.2.2 Attainment and educational triage

Taking the finding of initial set placement overlap further, it is interesting to consider what happens to the attainment ranges of these sets over the academic year. The post-test maths ages and gains for Year 6 at Avenue were given in Table 7. Maths age gains are illustrated further in the boxplot in Figure 6.

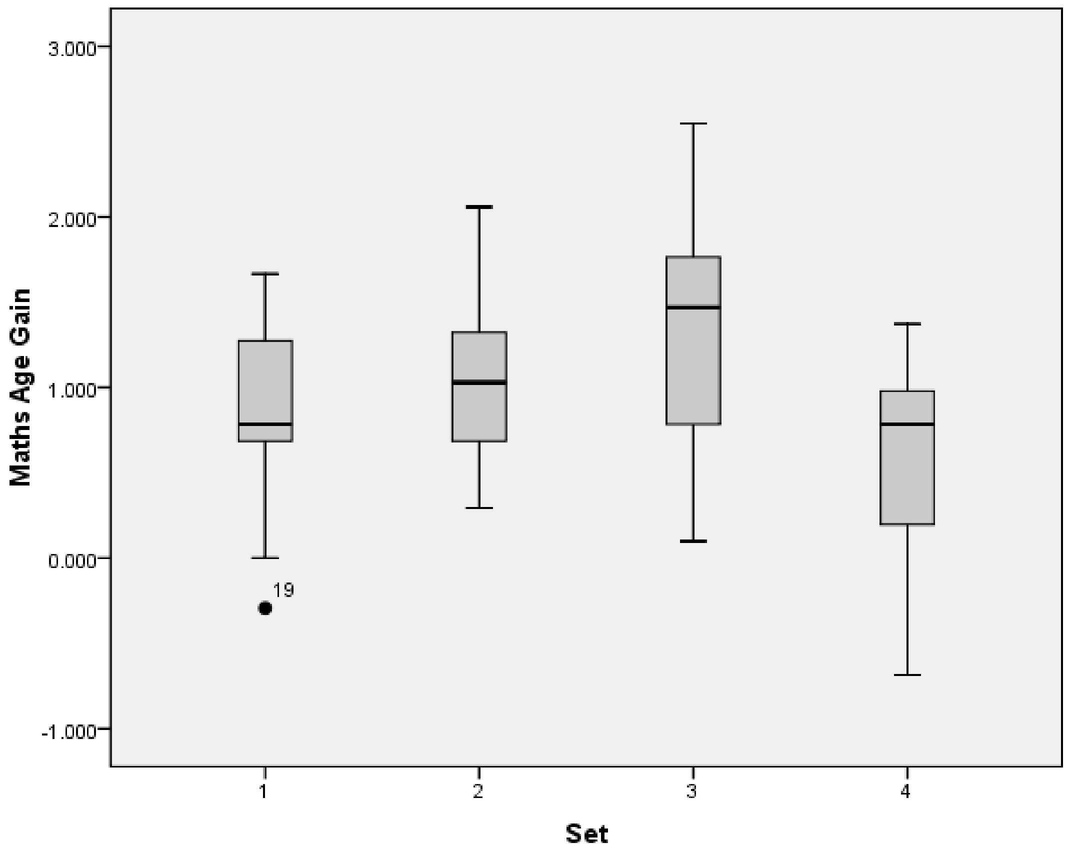


Figure 6: Boxplot of maths age gains for each set - Avenue Year 6

Some caution must be taken with interpretation given the small sample sizes, particularly with the lower sets. However, an ANOVA test suggests that there are significant differences between the gains made by each set, $F(3,67) = 4.503$, $p = 0.006$. Post-hoc Tukey HSD show the significant differences to lie between sets 1 and 3 at the $p = 0.05$ level and between sets 3 and 4 at the $p = 0.01$ level. The significant difference between set 3 and 4 gains are particularly important to consider as they result in a significant increase in the attainment gap between these sets over the course of the academic year. This may suggest that pupils in different sets are receiving different educational opportunities, with an apparent emphasis on raising the attainment of Set 3. These results and interpretation fit the aims of Avenue Primary where Set 3, also known as the Cusp Group, receive targeted support to raise their attainment to the national average (Level 4 in the Year 6 SATs). Pupils in Set 4 are not expected to achieve this average level and are not given such targeted support. The targeting of resources on set 3 / Cusp Group would account for the increased attainment gap between Set 3 and Set 4, although this requires further qualitative research in order to understand the processes occurring and how they are experienced, and hence able to have this impact, by the pupils.

A focus on Set 3 is reflective of the current literature on educational triage discussed in section 3.4.1. The process of targeting resources at Set 3 pupils – those pupils deemed to currently be performing at a level below the required level but who, with support, can achieve the desired outcomes – is outlined both by Gillborn and Youdell (2000) at the secondary level in the UK, and by Booher-Jennings (2005) at the primary level in the US. As such, the findings of this section are important in adding to the existing literature, providing evidence of the same processes, and their outcomes, occurring within UK primary mathematics education.

This finding from the quantitative data, which would be considered by critical realists to be an apparent regularity in the data, is important in identifying potential processes occurring. However, the addition of qualitative data explaining how the processes occur and are experienced is required in making stronger statements about the possibility of education triage occurring. In section 10.3.2 I examine qualitatively the practices occurring in different sets which may allow these quantitative differences to emerge, before bringing both quantitative and qualitative data evidence together in the discussion in Chapter 12.

The key finding of this section:

> *Over the academic year, the attainment gap between pupils in Set 3 (Cusp Group) and Set 4 in Year 6 increases significantly. This may*

suggest a process of educational triage occurring with a targeted input to raise the achievement of Set 3 pupils to a Level 4 in the Year 6 SATs.

6.2.3 Perceived ability

Further important findings from the quantitative data for this study analysis arose from the perceived ability section of the pupil questionnaire. In this section I briefly discuss these findings and their significance, highlighting links with the subsequent qualitative analysis.

The self-perception of ability scores for the second administration of the questionnaire covered the range of available scores from 0 - 100 with a median value of 68.5. These are illustrated in the boxplot in Figure 7. These data are significantly non-normal, $D(239) = 0.09$, $p < 0.0001$, being negatively skewed ($Z_{skewness} = -4.73$). The important issue to note here is that a median of 68.5 suggests a tendency towards more positive self-perceptions. However, as the boxplot for the full data set in Figure 7 shows, there is a long tail of weak self-beliefs with outliers representing pupils holding very low perceptions of their mathematical ability.[10]

Although the tendency towards more positive self-perceptions seems positive, the long tail of weaker beliefs requires further qualitative exploration in order to understand which pupils are reporting these beliefs and potential reasons for holding these. These will be examined further in Chapter 7 in which I look at how pupils produce and come to understand mathematical ability. These weaker self-beliefs will also be brought together with the qualitative data in Chapter 12 in drawing out the key findings of this thesis.

[10] Some caution is required in interpretation given that Nicholls et al. (1990) removed the self-perceptions of ability item from subsequent developments of their instrument and hence the validity of this measure is not as rigorous as for other instrument items (although piloting suggested high test – re-test reliability). For further details see the discussion in section 4.5.2.3.

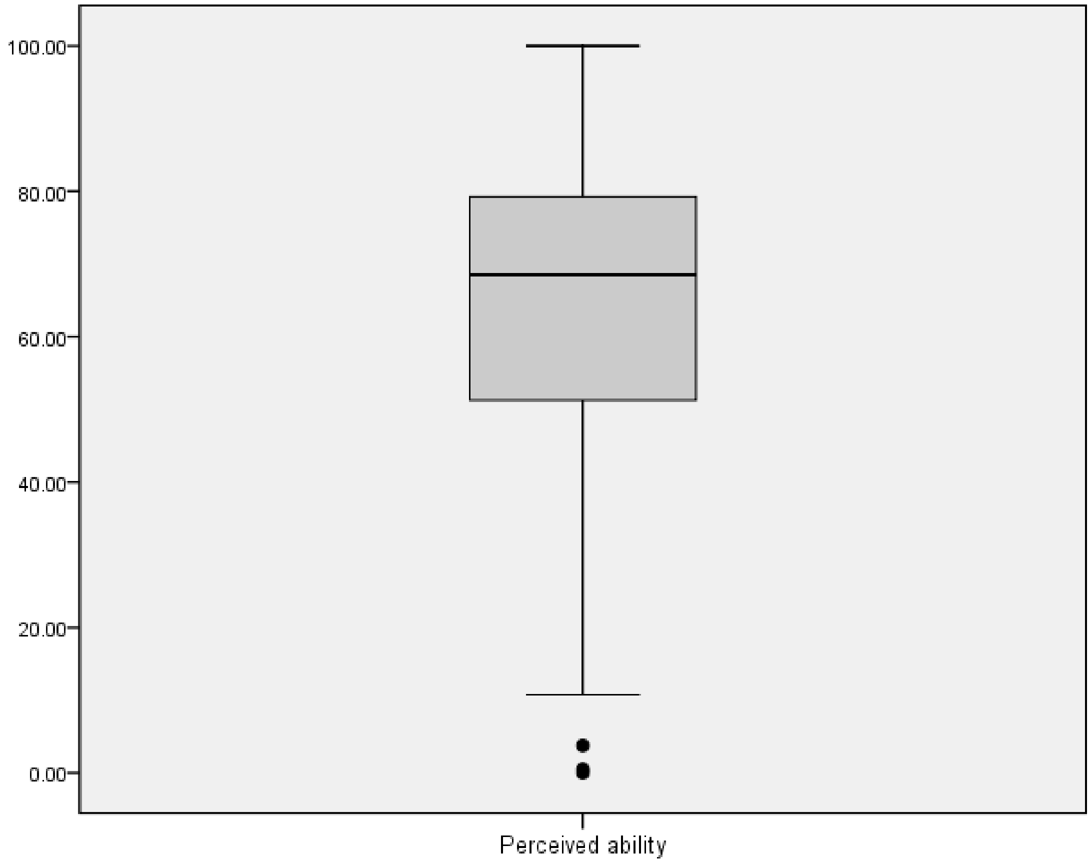


Figure 7: Boxplot of perceived ability – full dataset

Change in ability-perception scores were calculated (post minus pre-test scores) (M=3.2, SE=1.4, sd=20.3) with scores ranging from -44.0 to +96.0. On average, there was a small increase in self-perceptions of ability between the first administration (M=61.4, SE=1.6, sd=23.0) and the second (M=64.6, SE=1.5, sd=20.9). This difference was not significant $t(396) = -1.46$, $p = 0.15$. Overall, pupils' perceptions of their ability remain fairly stable over the year. In combination with the finding of some pupils holding weaker self-beliefs, this is an important regularity to be examined further through the qualitative data as it may suggest that pupils' productions of ability are themselves stable with limited possibility for change. This will be explored in depth in Chapter 7 in which I look qualitatively at pupils' productions of mathematical ability and whether these are produced as stable or changeable entities.

The key finding of this section:

> *Self-perceptions of ability appear to remain fairly stable over the academic year. There is a tendency towards positive self-perceptions but this is accompanied by a long tail of weak self-beliefs.*

6.3 Affective Relationships

The data presented in section 6.2 represent the strongest findings from the quantitative data analysis. These findings do not represent the full extent of quantitative data analysed within this study. In particular, extensive analysis was conducted on the pre- and post-test pupil questionnaires. Beyond perceived ability discussed in the previous section, three areas were explored: enjoyment, beliefs about the causes of success and motivational orientations. Each were looked at across the data set and split by school, year and set position. They were also looked at in terms of their interaction with other quantitative variables, namely attainment, enjoyment and perceived ability.

A variety of descriptive and inferential statistical techniques were employed exploring significance levels, effect sizes, and correlations. The results were generally non-significant showing few differences in the affective relationships. However, results from this analysis also highlighted some contradictions. As such, further detailed statistical analyses were conducted to make sense of the data. Prior attainment was brought in alongside school, year and the impact of being set in order to understand the contribution of each variable to pupils' beliefs. Simple and multiple regressions were conducted alongside multivariate analysis of variance (MANOVA) tests, ANOVAs for each dependent variable and Tukey HSD post-hoc tests. These tests allowed me to explore the strength of the contribution of each variable and the impact being set has on pupils' beliefs over other variables. Generally, the results were inconclusive, reflecting the small sample size of the schools and the conflation of setting with school effect and attainment. There were some surprising results, for instance in the direction of effects with beliefs about Competitiveness. However, it was decided that presenting that analysis would not add to this chapter; with it being more important to emphasise the qualitative data in the following chapters.

Reported enjoyment scores, which remained stable over the year, covered the full range (0 - 100) with $M=56.00$, $SE=1.87$ and $sd=28.89$. This suggests that whilst pupils have very different experiences, over half report a fairly positive affect towards mathematics. Neither school nor year-group had a significant impact on reported enjoyment levels. Analysis of set position and enjoyment produced mixed results suggesting the relationships to be complex. Year 6 top sets reported the lowest levels of enjoyment, whilst middle sets in Year 6 at Avenue reported the highest levels.

Mirroring the discussion in the literature review, enjoyment levels were found not to correlate significantly with attainment, suggesting the difficulty in understanding enjoyment in mathematics. Enjoyment did correlate significantly with perceived ability ($r = 0.454$, $p < 0.001$) yet this does not explain the direction of causality. It is likely that factors related to, but also additional to, setting, may be implicated in these differences, and this area would benefit more from qualitative exploration. This is covered in chapter 8 looking at the top and bottom set learning experience as well as in chapters 9, 10 and 11 which consider aspects, such as beliefs about the nature of mathematics, which are likely to be implicated in pupils' enjoyment of the subject.

The results from the beliefs about the causes of success questionnaire provide a quantitative assessment of pupils' thoughts regarding why pupils do well in mathematics across four beliefs: Interest and Effort, Understanding, Competitiveness and Extrinsic Factors. Across the dataset, pupils' strongest belief is in Interest & Effort as a cause of success whilst their weakest belief is in Competitiveness. This may seem surprising in that it does not fully reflect the literature (although this is mainly in secondary mathematics). However, these quantitative results do not say anything about where these beliefs arise from or the impact of holding different beliefs; these are issues to be explored further qualitatively. Although a pragmatic decision was made not to focus on gender in this study, it was important to ascertain whether there were significant differences in beliefs based on gender, particularly as Boaler's (1997c) study found significant differences between boys' and girls' beliefs. Results for the present study indicate no significant differences in the strength of each belief between boys and girls.

The only significant difference across the schools or year groups was in Parkview pupils being more likely than Avenue pupils to see Competitiveness as a cause of success, although this factor had a low mean for both schools. There were limited relationships in beliefs across sets in each school and year-group. Although non-significant it was found that in Year 6, pupils in the top sets hold higher beliefs than pupils in other sets that Competitiveness is a cause of success. Given these results, it will be important to explore the issue of competition, particularly through assessment practices, in more detail qualitatively. This is considered in detail in section 8.4 looking at secondary school selection and in section 11.2.1 which considers the impact of SATs. Further, related beliefs, in relation to productions of ability, are considered in Chapter 7.

The results from the motivational orientation aspect of the questionnaire provide a quantitative assessment of pupils' orientations towards learning mathematics across three orientations: Task, Ego and Work Avoidance. Across the dataset, the strongest motivational orientation is a Task orientation although there were no significant differences in the strengths of each motivation. The patterns of motivational orientations across the sets in each school and year-group are multifaceted. In Year 6 at Avenue, Set 1 pupils are significantly more Ego orientated than lower-set pupils, a finding which again adds to the need for a qualitative exploration of competitiveness and assessment practices discussed in the previous section.

In relation to other variables, Ego ($r = 0.207$, $p = 0.002$) and Work Avoidance ($r = -0.231$, $p < 0.001$) orientations correlate significantly with attainment; the strength of Ego orientation increases alongside attainment whilst the propensity towards Work Avoidance decreases as attainment increases. Task ($r = 0.228$, $p = 0.001$) and Ego ($r = 0.235$, $p < 0.001$) motivational orientations are both significantly positively correlated with perceived ability. The strength of pupils' Task orientation was significantly positively correlated with enjoyment ($r = 0.498$, $p < 0.001$) and Work Avoidance ($r = -0.305$, $p < 0.001$) is significantly negatively correlated with enjoyment. Although some care must be taken as there is collinearity between variables such as a Task orientation and enjoyment, these findings provide an indication of areas to be examined further qualitatively. For instance, the negative correlation between enjoyment and Work Avoidance may suggest that pupils derive enjoyment from being set more challenging work. These issues will be examined in Chapter 8, looking at top and bottom set teaching and learning experiences.

6.4 Chapter Conclusion: Quantitative and Qualitative Data Integration

In this chapter I have argued for the research to be considered as a mixed-methods study drawing on a critical realist approach to method and on the apparent limited use of mixed-methods research in mathematics education. I have noted that this thesis will appear strongly weighted towards a qualitative study. In part this is because the qualitative elements represent the stronger elements of the study, particularly with its relatively small sample size. However, the focus on qualitative data will seem more intense as much of the quantitative data collected and analysed is not reported within this thesis. This was a pragmatic decision following the analysis stage: rather than standing alone, the quantitative analysis produced, as critical realists call for, apparent regularities (and also highlighted non-significant relationships) to be followed up in looking at potential explanations through qualitative analysis. In this way this study was mixed methods in that this approach could not have been taken with only quantitative or qualitative data collection and analysis.

In section 6.2 I highlighted three findings from the quantitative analysis. Whilst these were some of the strongest quantitative findings, it would still not be appropriate, given the limited dataset, to make any strong claims based on this data. However, these indicate how the quantitative aspects of the data analysis were beneficial in identifying apparent regularities and links with the existing literature, which could then be followed up through the qualitative analysis. These findings provided a basis to structure and take the qualitative analysis forwards, and an indication of where this qualitative analysis is to be found in the subsequent chapters was given following each finding. I also highlighted, in section 6.3, the predominantly non-significant relationships found in the affective data. This was an important finding in itself and fits with much of the literature on the complexity of investigating affect in mathematics education. Again it highlights the need for qualitative investigation of the factors – such as enjoyment and beliefs – considered within the questionnaire, but also stresses the importance of the quantitative work having been conducted, adding further weight to the argument for this to be considered as a mixed-methods study.

The following chapters – chapters 7-11 – present the qualitative data analysis of this thesis related to the objectives of the study and themes arising in the analysis. These include findings that draw solely on qualitative analysis and others that either extend (as in the case of some affective relationships) or have their basis in (as in educational triage) the quantitative findings presented in this chapter. In chapter 12, the conclusion to the thesis, I identify and justify the contribution of the research to current knowledge. In outlining the major findings of the research, I draw on both the quantitative analysis reported here and on the subsequent qualitative analysis.

7 The Production of Mathematical-Ability

7.1 Introduction

In the previous chapter, exploring, from a critical realist perspective, apparent regularities in aspects of the quantitative data, I highlighted areas where potential relationships in specific areas of the data would benefit from examination in more depth through qualitative analysis. This chapter is the first of five predominantly qualitative chapters.

In Chapter 3 I discussed ability as a powerful ideology in the UK. I examined social understandings – predominantly involving genetic heritability and upper limits – which characterise how ability is often used in schools. Whilst there have been recent attempts to bring the fields of education and neuroscience together this has been fraught with difficulties (Ansari & Coch, 2006; Willingham & Lloyd, 2007) resulting in little more than ‘neuromyths’ (Geake, 2008) entering education. These myths, packaged as ‘brain-based learning’ (Goswami, 2006, p. 2), have wide appeal within education and may strengthen some ability beliefs held by teachers and transmitted to pupils.

In this chapter I explore beliefs about ability within primary mathematics education as held by pupils and teachers. In particular I examine how they produce ability and what these productions consist of. For clarity I split this analysis into two sections: location and discourses. Location looks at where pupils and teachers take ability to be located, whether an internal construct or something having a more transient nature. This is important as different locations are likely to reflect different beliefs about the nature of ability. Within discourses I look at the language used to talk about difference. In line with my approach to discourse outlined in Chapter 2, I am concerned with the different words used to refer to differing levels of achievement and how these develop.

7.2 Locating Mathematical-Ability

The quantitative analysis on pupils’ self-perceptions of ability discussed in section 6.2.3 suggested, through the limited changes in pupils’ self-perceptions between the pre- and post-tests, that there may be a degree of stability in how pupils think about ability with pupils believing they have little agency in affecting change. This is an important association to be examined further, and in this section, in which I examine where pupils are locating mathematical ability, I use the qualitative data to examine this quantitative association in depth, exploring the extent to which pupils are producing a stable or changeable entity.

Mirroring Hamilton's (2002) secondary-school work on ability constructions, I split my analysis into internal beliefs and external references. Social conceptions of ability as fixed and heritable locate the quality within the individual and it seems plausible that teachers may hold these same conceptions. Understanding where ability is seen as located is important for exploring how productions impact on pupils and teachers. Location is linked with different theories of learning that pupils and teachers may hold, for instance Dweck's (2000) work on entity and incremental theories. Where individuals hold entity fixed trait theories, they tend to work under an ability as capacity perspective (Nicholls, 1989). Conversely, an incremental theory with a belief in the capacity for change corresponds more with a malleable understanding dependent on external factors.

For the majority of pupils and teachers in this study, there was a discernible bias in the location of mathematical-ability. Qualitative data were coded to explore whether ability was talked about in an internal way or in relation to external factors. Table 8 shows the number of data segments coded as giving an internal or external location. This table suggests that Avenue pupils were more likely to produce internal locations for ability than pupils at Parkview, possibly representing a more dominant innate ability discourse within the school.

	Avenue	Parkview	Total
Internal	83	38	**121**
External	20	32	**52**
Total	**103**	**70**	**173**

Table 8: Internal and external ability locations

At both schools, pupils, and particularly teachers, talked about ability as if it had one consistent meaning understandable to all. Ability was a natural part of the staff's language. This is reflected in this interaction between teachers and TAs:

> I was in the staffroom at lunchtime working on post-interview notes whilst a group of three teachers and TAs were working on the planning and production of resources for a mathematics lesson. Early in their discussion they were talking in terms of the work each ability-group should be given to do with stark differences in their assumptions of what individuals of different ability were capable of. Working down through the groups, the most animated discussion concerned what they were going to do with the low-ability who were "not confident enough in speaking and listening to do the maths." It was decided that the activities for this group would involve less work and predominantly consist of colouring in, cutting out and sticking. I found this very difficult, both because their discussion and tasks gave no room for pupils to be anything other than the label they had been assigned and because of a very stark realisation that these were the exact same discourses and practices I had at times engaged in as a teacher and that were being repeated as the norm up and down the country.
>
> (Parkview, 27.11.07)

This extract, reflecting the literature, suggests social conceptions of ability as a fixed internal quality to be commonplace at Parkview, if not more widely. It is likely that staff, as in the above extract, bring societal ideologies to bear on their work within the classroom. It is important to understand what pupils are bringing to the classroom, from where, and how teachers' beliefs may be transmitted to pupils. Understanding the location of productions of ability is important as it provides a possibility for looking at where current practices could be transformed and change could take place. Hart, Dixon, Drummond, & McIntyre (2004) espouse a clear argument against the use of ability labelling but also acknowledge how powerful the dominant innate ability discourse is in that it can limit teachers' capacity to see other explanations for difference. Table 8 suggests that there are differences in where ability is seen as located between the schools and exploring these locations and differences may help us understand what allows some to develop different and multifaceted explanations for difference whilst others remain tied to a rigid internal limits conception of ability.

7.2.1 Ability as internal to the individual

For many participants in this study, ability, mirroring societal conceptions, is seen as something real and located within the individual rather than being an aspect of a person's developing and changeable identity. Ability discourses at Avenue were strongly distorted towards an internal view. However, at both schools, pupils talked about individual difference with a shared understanding. Talking about such difference seemed a natural discourse to the pupils and strong links emerged between this and all forms of ability-grouping:

> Uma: Cause it's like the erm, ability of what you can do, so there's like a high, there's like a top maths group, then a middle maths group then a bottom maths group
>
> Victoria: And then you know which one is which
>
> Uma: Because if you are like in one big maths group and you're all different abilities then there might be something too hard for like the people that need to do easy questions, and the people that need to do it hard, it would be too easy for those people
>
> (Avenue, Y4, S1, 07.02.08, Lines 6-12)

> Helen: There are like different abilities on different tables, like the cleverest people go on a certain table
>
> (Parkview, Y4, Mixed-Ability, 15.01.08, Lines 71-72)

In interviews, the pupils introduced the language of ability themselves; I only using this terminology to clarify or extend what participants had said. In the Avenue extract above the pupils brought the terminology in at the beginning of the interview in response to being asked generally about their mathematics lessons. For these pupils, ability and grouping were something important enough to be brought to mind to talk about when asked to describe their mathematics lessons. In effect ability, and the practices of ability, were important constituents of what mathematics is. Both extracts carry an unquestioned assumption that there are different types of people in terms of ability levels and these can be clearly demarcated into groups. Based on this belief in clear groups, pupils voiced an acceptance that "some people are more clever than other people" (Parkview, Y6, S1, 21.01.08, Lines 13-14). Pupils accepted that this was right without question. It seems likely that these beliefs are influenced by prevailing ability practices:

> Natalie: Well some people are just, you know, cleverer than other children, that's what decided our groups in year 3 and it hasn't changed.
>
> (Avenue, Y6, S1, 03.06.08, Lines 242-243)

The pupils (and teachers) have an explanation that works to fit what they see. Natalie's extract suggests that it is the individual differences between pupils that led directly to the groups and that these have not changed as differences are innate and unchangeable. Such a view, where it is what is internal to an individual that influences outcomes, is very fixed and self-perpetuating. Ability becomes an internal force that not only drives, but also limits, what you can do. External factors are not seen as contributory to outcomes and as such, a belief that individuals can only take their attainment to a maximum level determined by internal limits prevails.

Conceptions based on innateness, reflecting teachers' beliefs (e.g. Hart, et al., 2004), were central in pupils' discussions. In their individual interviews I asked each pupil if they felt they could improve upon their current position. The responses across schools, sets and year-groups were consistent and stark:

> "I think I would not move. I think I would normally stay in the same place. I don't think there's anything I could do to make myself better."
>
> (Zackary, Avenue, Y4, S4, LA, 20.11.07, Lines 39-40)

> "No, because I'm not smart enough like that, I'm not really good at using my times tables."
>
> (Kelly, Parkview, Y4, MA, 07.12.07, Lines 51-52)

> "I think I could move a few centimetres further up the line, not far"
>
> (Megan, Avenue, Y6, S1, HA, 11.12.07, Lines 48-49)

> "Just about here, not a huge way, well because you can only do so much can't you, it's quite hard."
>
> (Peter, Avenue, Y6, S4, HA, 21.11.07, Lines 64-65)

The majority of pupils suggested limited room for improvement. Pupils produced, without question, innate ability led labels and ways of working. They positioned themselves within a hierarchy seen as normal and accepted the place they, their teachers and others gave them. This sense of futility is concerning, having the implication of pupils believing that effort could not make a difference to achievement. This may appear at odds with the quantitative data presented in section 6.3 where, across the dataset, pupils most associated Interest and Effort with doing well in mathematics. The interpretation of this quantitative data required some caution. Two items within Interest and Effort – 'They always do their best' and 'They work really hard' – were both scored highly and contributed to the high mean for Interest and Effort. These items may reflect common school discourses about 'doing well' rather than more deeply held beliefs or they may reflect beliefs about individuals who do well (see section 7.3.1) rather than as causes of doing well. Overall the data suggest that beliefs are not simple and that multiple issues are likely to impact upon them. Even in terms of specific mathematical skills, such as in Kelly's extract where she talked about not being good with her times tables, there is no assumption that teaching and learning will make a difference as she does not 'have' something that others do which will allow her to improve. As Peter's extract exemplifies, having this internal quality is about individual static difference and cannot be changed. His statement was not made as a question, but as an acceptance coupled with an assumed shared understanding with me as the interviewer.

A belief in ability as fixed led to assumptions of potential and upper attainable limits. This was talked about by teachers in terms of underachievement:

> "Ivy would be someone who has come on, has again, has more ability than she will show, whether that's confidence, or, you know in terms of wanting to do it, but she's far from the least able in the year-group, but you know, needs a lot of progress to develop further."
>
> (Mr Donaldson, Parkview, Y4, 21.07.08, Lines 11-14)

For pupils like Ivy, teachers and sometimes pupils talked about knowing that a pupil had more ability than they demonstrated; that academic outcomes did not match perceived ability. Potential took on a one-way discussion. Pupils could be talked about as not using all the ability they had, but they were not talked about as having academic outcomes suggesting more ability than they were thought to have.

The concept of individual boundaries neatly described as ability is entrenched in social attitudes and a belief in the 'correctness' of this underlies many educational debates. This was vividly illustrated during a television discussion on 11+ selection which became a discussion of the need for further streaming and setting across education:

> 'It seems to me that 1000 kids in a comprehensive, sooner or later, the ones who are good at maths will have to be told "you are good at maths" and the ones who aren't, will have to be told "you are not good at maths" and you should be doing your darnedest to break the barriers but you should be learning as a young person that there are limits to what you can do.' (Richard D. North, Social Affairs Unit, The Big Questions, BBC1, 26.07.2009)

The underlying assumptions of limits were not challenged, presumably because such understanding is so pervasive. These beliefs are not limited to theoretical debates; pupils in the present study used a similar discourse in talking about themselves and others:

> Rachel: Could anything help you to improve?

Uma: Yes, if we had something like, Mr Iverson, if he explained it out a couple of times and actually came up to me in the lesson and talked it through then I would understand it a bit better.

Rachel: Could that make you move up higher?

Uma: No, because I have some trouble on a lot of sums with carrying over. I'm way past there in history though, but not in maths, there's this bit [≈ the top 20% of the line] I can't get.

(Uma, Avenue, Y4, S1, MA, 11.12.07, Lines 46-52)

Uma felt that she could improve on some specific difficulties. However, she sees the impetus for improvement as coming from something outside of her control, in this case more individual input from her set-teacher. Despite this potential for improvement, Uma did not see it as having an impact on her ability which she saw as a fixed internal entity. She talked about a part she would never be able to get, even with teaching, suggesting great futility and a strong belief in upper boundaries. The idea that whatever effort an individual puts in they will never be able to extend their predestined upper limits was strong within the pupils' discourse:

Natalie: I don't think all children can do really well in maths though

Megan: Even if they tried really hard, even if they tried really hard

Natalie: If they tried really hard their best might not be a 5A, but if you have lots of ability and you tried your best then you would do very well in maths. So not all children can do well.

[…]

Natalie: If you're determined you might be better but I don't think all children, I don't think, all children can't be, well they could be okay at maths but not really brilliant, because

Megan: Well you could have people who had lots of ability but they just weren't trying hard enough so they were considered to be not as good but then when they try hard they are really good, but they have to have lots of ability.

(Avenue, Y6, S1, 03.06.08, Lines 204-208, 246-250)

Here again Natalie and Megan suggest that you can have ability and not use it but that what you have is limited and you cannot move beyond those limits; effort cannot be enough to achieve success. This belief has huge implications for education and appears to be entrenched in pupils at a young age. Under these beliefs, pupils are limited by what they feel they can do and by limits imposed by the assumptions of their ability label:

> "We'll only go with numbers up to 500, we won't be going up to 5000, or 500000 which you would need to do if you were, if you had the whole gamete."
>
> (Mrs Jerrett, Avenue, Y4, S4, 16.07.08, Lines 153-155)

In this extract, Mrs Jerrett was talking about how she caters for the perceived needs of her bottom-set. Only working with small numbers when discussing lower-ability pupils was a common theme, an action which is immediately restrictive and removes something of what many pupils find exciting about mathematics. This restriction may lead to tensions:

> The pupils are learning about place value. As part of the warm up to the activity, the teacher is asking them to count backwards in tens from different starting numbers to explore which digits change. As there are only a few pupils in the class today she is doing this individually with selected pupils, 'challenging' them to start from different numbers:
>
> Mrs Jerrett: Right Charlie, I want you to start from…
>
> Charlie: [interrupts the teacher]…Two thousand, six hundred and ninety eight
>
> Mrs Jerrett: Oh no, we'll keep it to the hundreds, I think 541
>
> Charlie: I want to do thousands. 2698, 2688, 2678, 2668…
>
> Mrs Jerrett: No, that's too difficult.
>
> (Avenue, Y4, S4, 07.02.08)

This suggests a tension exists between actions and different actors' understandings. In using smaller numbers the teacher is not maliciously restricting pupils' opportunities and may be taking on a caring and protective role (Forrester, 2005), but she is reproducing the social discourse prevalent in our education system. Working under a belief that individuals have a fixed level of ability, Mrs Jerrett's actions could be interpreted by the pupils as using the ability they have rather than expending energy on tasks beyond their capabilities. Of course, conceptions of ability are likely to be just one issue here alongside other well documented problems, for instance teacher knowledge.

The ability discourse practitioners are immersed in is built upon an historically embedded conviction in intelligence theory. It is perhaps unsurprising, therefore, that ability is often conflated with intelligence and such terminology is used to differentiate peers and place limits on achievement. It is suggested that the persisting structures in mathematics 'may encourage perceived cognitive boundaries' (Brown, et al., 2008, p. 8), closely related to ideas of innate intelligence. My data extends this within primary mathematics and also suggests that as well as perceived cognitive boundaries, there may be an overt application of intelligence:

> As an oral mental starter activity, a grid of numbers is on display on the interactive whiteboard at the front of the class:

765	830			1025
		927		
	894		1024	1089
861				
			1088	
925				

> Pupils are asked, in silence, to copy this onto their individual whiteboards, to work out the pattern in the table and to complete the table. Some pupils, having worked out the pattern, do not actually work out the numbers or write much down; no attention is drawn to this by the teacher (Miss Gundry). Pupils are only given a short while to complete the table. After this time, the teacher does not ask how the pattern is formed but goes through the cells in order asking the pupils for the correct number. This is done very quickly and pupils are praised for providing answers at speed. One pupil calls out that he has 'spotted a pattern to do it quickly – if you move one to the left and down two squares, the number decreases by one'. At this, other pupils in the class turn to him and aloud tell him he is 'scary'. The teacher responds, telling the set that spotting patterns like that is a sign of intelligence and that they have a genius in their midst.
>
> (Avenue, Y6, S1, 29.01.08)

Here the teacher interprets the pupils' observations, translating what they describe as "scary" into intelligence (whether this was their intended meaning or not). "Scary" could be included within Picker and Berry's (2000, p. 75) category of the disparagement of mathematicians, seen as 'too clever', with what is seen reflected in less common discourse. Within the community of the mathematics classroom, the meanings of the incident are, as Wenger (1998) asserts, being negotiated between members. The incident provides space for pupils to be apprenticed into social discourse, whilst the addition of "genius" may intensify the discussion of intelligence. This teacher talked further about pupil difference in interview:

> "That's sort of intelligence, I don't know, that's humans. I don't know enough about why humans, you know, I don't know enough about why some people are not as intelligent as other people."
>
> (Miss Gundry, Avenue, Y6, S1, 16.07.08, Lines 90-92)

Again, she refers to intelligence as a marker of individual difference. Whilst acknowledging a limited understanding of the causes of differences, she assumes what she understands to be sound; that intelligence is a real entity used to reliably demarcate individuals. She uses intelligence interchangeably with ability and vice versa to mean the same thing and with the same assumptions. Pupils, as well as teachers, used a discourse of intelligence:

> Delyth: Oralia's probably the most, do you think Oralia's the most intelligent person in the class?
>
> Finn: Yeah, that's what I meant, on the sheet.
>
> Delyth: Yeah, Oralia is, she's the most intelligent person in the class.
>
> Emily: Probably maybe even in the year.
>
> Delyth: Mary's quite intelligent. There are other people. But maybe in the class she's the most intelligent.
>
> (Parkview, Y6, S2, 12.02.08, Lines 221-227)

Intelligence is as natural a language as ability for pupils with the same assumptions and limitations. Differences are seen as measurable and just, simply reflecting what is normal. People are seen as different, with ability providing a simple explanation for individual success and failure (Ruthven, 1987). As one pupil, Uma, succinctly put it, "people are different" (Avenue, Y4, S1, 07.02.08, Line 30); no further explanation was deemed necessary.

Many pupils alluded to more specific issues of natural variation and individual brain and/or genetic differences. Whether pupils were set, and their set placement, was associated with how likely they were to draw on these reasons. As Table 9 shows, pupils experiencing setting made more references to individual brain differences, with pupils in top sets being most likely to give such an explanation.

Pupils in …	References made in interview to brain differences or natural variation as a reason for attainment differences
Mixed-ability classes (2 classes)	2
Bottom sets (3 classes)	4
Top sets (3 classes)	16
Total	**22**

Table 9: Pupils' references to internal/natural variation

Natural variation was seen as an innate difference existing from birth "because you are born with an ability" (Victoria, Avenue, Y4, S1, 06.05.08, Line 94) or "born to really do well" (Megan, Avenue, Y6, S1, 03.06.08, Line 244). In relation to mathematics, pupils talked about those who were good at maths as being born to be good at maths and vice versa, sometimes referring to brain size and difference:

> Rachel: So what makes someone good at maths?
>
> Wynne: Their brain's bigger. And they're cleverer and better […] I don't know, it just happens. They were born like that. They were born clever.
>
> Rachel: And what might make someone not good at maths?
>
> Zackary: Some people are just not born clever.
>
> (Avenue, Y4, S4, 30.04.08, Lines 46-61)

Such assumptions may reflect the earlier discussion of cognitive limits. For many pupils there was a clear distinction between pupils in terms of mathematical-ability:

> "Some people are really good at maths and some people aren't that good at maths. Probably it sometimes runs in the family."
>
> (Yolanda, Avenue, Y4, S4, MA, 07.05.08, Lines 32-33)

In Yolanda's extract, the suggestion that people are born to be good or bad at maths is taken further. She brings in something that may extend further than the individual to include familial traits. Pupils and teachers went further into the individual in their discussion of difference taking what may be deemed a cognitive neuro-scientific approach to explain individual differences:

> "The top-group are very good auditory learners, so in other words they can listen to instructions and remember things from listening and then use that to learn, whereas if you go to the other extreme, the bottom-group, they're more kinaesthetic, where they need to move things around and touchy feely, I'm generalising but the middle-group they learn visually, so, these, they're very strong at all of these, auditory, visual, kinaesthetic, but particularly good auditory learners, so when I am at the front talking and explaining they will remember things and then they can use that rather than forgetting."
>
> (Mr Iverson, Avenue, Y4, S1, 16.07.08, Lines 59-66)

In Mr Iverson's extract, one strong educational outcome of the increased interest in neurocognitive research in education – learning styles – comes through strongly. Multiple references to learning styles were made by teachers highlighting their current dominance and reflecting teachers' widespread belief in such theories (Pickering & Howard-Jones, 2007) despite no evidence being found for their effectiveness (Coffield, Moseley, Hall, &

Ecclestone, 2004). Using a learning styles approach, it is suggested that pupils can be fitted into three fairly simplistic groups – visual, auditory and kinaesthetic learners – each with its own learning bias. Teachers framed pupils' learning differences in terms of these styles, with pupils reproducing these differences as natural and with the potential to lead towards an intensification of innateness beliefs. In particular, they appeared to emphasise the social belief where it is common to hear people describe themselves as "not a maths person", making such an idea appear normal and acceptable:

> "I suppose, they, they are just beginning to become aware that some people are more literacy type people and some people are more maths and science type people, they're getting to that age."
>
> (Miss Gundry, Avenue, Y6, S1, 16.07.08, Lines 154-156)

> "Maths is one of those subjects where sometimes they can have a real ability at maths but be really struggling in other subjects, you know you're rarely going to have a child who's an excellent writer but is terrible at everything else whereas sometimes with maths it can definitely be the other way, I mean I've seen kids oh goodness, got 100/100 in the maths SATs tests at the end of year 6 but they've really struggled to squeeze a level 4 for their reading and their writing … Some people have got a very mathematical mind, that is analytical, they're just that kind of learner that lends itself more mathematically."
>
> (Mr Donaldson, Parkview, Y4, 21.07.08, Lines 132-143)

Here, both teachers reflect popular discourse. They hold the belief that individuals are either mathematical or not, that to be mathematical is somehow special and that it requires having a particular type of mind. These beliefs are transferred to pupils through non-intentional reproductive practices such as within the Avenue lesson observation discussed previously. Other potential reproductive practices are discussed in subsequent chapters.

7.2.2 Ability as external to the individual

Having looked at how ability may be given an internal location, I now look at where it is given an external location. External locations involve incremental theories where pupils and teachers express possibility for academic movement, seeing ability as changeable. It is important to explore where such understandings of ability develop as these provide us with opportunities to move towards a transformability mindset (Hart, et al., 2004) and support all pupils, rather than a selected few, in their mathematical development.

As shown in Table 8 in section 7.2, relatively few statements made regarding the location of ability made reference to it being external. This was highlighted in pupils' responses to being asked about the possibility of movement. Few pupils suggested they could move at all and those that believed they could move placed boundaries on movement. Many statements classified as external still retained ties with a fixed mindset. Very few were wholly incremental.

Statements that were external fell into a few specific groups. One area was secondary selection. The impact of selection on pupils in terms of notions of ability is discussed in section 8.4. Pupils' understandings here were confused, for whilst they talked extensively about Grammar schools and these only being for pupils with high levels of innate ability – hence an internal location – they also talked about using tutoring to improve and secure an advantage, suggesting an external influence on ability. However, it should be noted that it was only those already attaining highly who talked about the use of tutoring in such a way; this may have been more about parental influence and examination technique, rather than a belief that tutoring could improve innate levels of ability. A similar paradox is highlighted by Stobart (2008) who refers to the use of coaching services to improve US SAT scores.

Further areas where qualitative statements had an external location were: ability as assessment outcomes and age/mastery. Where ability is conceptualised as assessment outcomes, it is usually because ability is seen as an 'alternative for "achievement" or "attainment"' (Stobart, 2008, p. 31), and that it does not allude to or share the assumptions of intelligence testing. As Stobart attests, ability as an alternative word for achievement is not the norm in the usage of ability in schools, with ability usually seen as the cause of achievement. Despite this, on limited occasions within this study, pupils and teachers did conflate ability and attainment without appearing to use an entity production:

> Rachel: How do you think the teacher decides where people would go on the line?
>
> Catherine: Well I think she has this folder and like you know when you get your grades I think she would put it on your grades.
>
> (Catherine, Parkview, Y6, S1, LA, 14.11.07, Lines 40-42)

> "When I looked at that line in the first place I thought of levels basically."
>
> (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 87-88)

It is important to remember that both the pupil and teacher here also provided evidence of entity mindsets and as such we cannot say from this evidence that ability is only being thought about as assessment outcomes. However, the above provides a way of understanding how and where ability may be being thought about differently. The above extracts concern a set-teacher (Miss Barton) and a pupil within her set (Catherine). It is therefore interesting to see these two describing the same process; the teacher describes using levels to place pupils on the line whilst the pupil makes an assumption that this is what the teacher is doing. Of course, there may be more than levels in the teacher's judgement, whether she is aware of this or not, and Catherine may be working under a mixed mindset.

A view of ability as attainment, particularly when innate views are brought in, may not be wholly positive. Pupils may come to define themselves and others by their levels (further data on this has previously been published in Hodgen & Marks, 2009). Assessment not only supports the production of an ability-identity through its labelling powers but also the direct production of understandings of ability. This may result in confusion:

> Helen: The cleverest table would be one of these. These are kind of the same ability; they're around the same level.
>
> (Parkview, Y4, 15.01.08, Lines 74-75)

> Megan: I think she knows your ability from previous SATs scores.
>
> (Avenue, Y6, S1, 29.04.08, Line 221)

In both extracts, ability and levels/test results are used as measures for each other. What cannot be told from these is whether assessment results are seen to stem from an innate quality or whether ability is seen simply as another word for attainment. Part of the difficulty with whether ability is seen simply as another term for attainment or as a cause of it, appears to exist in the differing roles assessment takes in education and a reliance, particularly in the latter stages of year 6, on summative assessment. The various functions of assessment exist in confusion and tension (Gardner, 2006) and whilst such a tension exists, it is harder for assessments to tell us about the qualities of an individual or for individual learning to be supported. There is confusion because on the one hand the majority of pupils and teachers locate and produce ability as an internal, innate and fixed heritable quality yet simultaneously they also refer to assessment outcomes as what ability is. Pupils and teachers may slip between these ways of thinking because they hold contradictory belief systems or are trying to make sense of the inconsistencies experienced. It is not possible to say from this data exactly when and where different productions were used.

These findings suggest that even where an external location and incremental theory was applied, this may have roots in, or occur concurrently with, an entity or fixed theory. The only, and very limited, area to come through in the data where only external beliefs were applied was in age or mastery learning. Even here, the same pupils also talked at other times about entity beliefs.

Pupils talked about the potential to change and to get better with age as they, or others, get older and are exposed to more mathematics teaching. Some pupils expressed change with age in terms of a reason for current poor performance:

> Rachel: And do you know anyone who would be at this end?
>
> George: Someone in nursery, because they are still learning 1 + 1.
>
> (George, Parkview, Y4, HA, 22.11.07, Lines 33-34)

> Rachel: Okay, do you know anyone who would be down here?
>
> Yolanda: My little brother. He's 4. He says that one and one makes sixteen. He'll get better when he gets older.
>
> (Yolanda, Avenue, Y4, S4, MA, 07.05.08, Lines 23-25)

> "No, I can think of someone here, because they're only young, they'll move when they get older."
>
> (Ben, Parkview, Y6, S1, MA, 27.11.07, Lines 62-63)

In each of these extracts, George, Yolanda and Ben gave reasons why someone would currently not be good at maths. They refer to young children who have not had much mathematical experience, inferring that these children will develop as they get older. No assumption of cognitive limits is brought into this discussion; it is expected that with age and experience, these pupils will improve. As well as talking about others, pupils also talked about themselves in terms of future age development. The assumption here is that with increased age will come more mathematical development and hence improvement, exemplified by Megan in terms of branches of mathematics she was yet to "come across":

> "There's some things I haven't come across yet which are like for older and I wouldn't be able to know about those things yet so if we came across them I wouldn't know them as much as the previous things."
>
> (Megan, Avenue, Y6, S1, HA, 11.12.07, Lines 51-53)

"I think I could edge forward bit by bit when I'm older"

(Olivia, Avenue, Y6, S1, LA, 30.01.08, Line 94)

Understanding the holding of multiple beliefs and the potential strength of one over the other will be important in considering areas for change. From the analysis presented in these sections, it appears that pupils in primary mathematics may be producing ability as a quality residing in fixed quantities, located within individuals and constraining achievement in the subject. There appears to be a belief that unless pupils hold enough mathematical-ability there is little that can be done to achieve more. Whilst achievement may improve with age, this relates to all pupils, and understandings of ability still rely on innate foundations.

7.3 Discourses of Mathematical-Ability

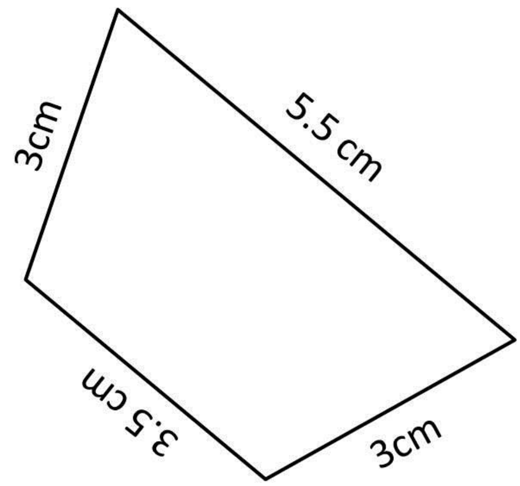
Having examined where individuals locate ability, I now look at what their productions comprise of. Although, often for ease of discussion, talked about as a thing people possess inside of themselves, productions are less singular and often a conglomerate of ideas. Quantitative evidence for the possibility of notions of ability being made up of multiple reference factors was suggested in section 6.2.1 where overlaps in set placement potentially indicated a range of factors being implicated in set placement decisions. The quantitative analysis in section 6.2.3, examining pupils' self-perceptions of ability also suggested that whilst pupils overall had a tendency towards more positive self-perceptions, there was a vast range in these with a long tail of weak self-beliefs. In this section, I explore these potential associations in more depth, using the qualitative data to understand how pupils and teachers are talking about mathematical ability and the extent to which this impacts on the judgements they make about themselves and others.

In this section I explore how ability is talked about, focussing on the language and descriptors used to talk about pupil differences. Pupils completed the Personal Construct Task without hesitation. In many cases they selected peers at different positions on the line, talking about them in terms of relative ability. No pupil struggled to place themselves or peers on the line and although this is what was asked of them, they did so with ease. In fact, as Howe (1997, p. 2) suggests to be the case with the wider population where 'people today have so little hesitation about ranking individuals as being more or less intelligent', many pupils appeared enthusiastic in positioning their peers.

Within school contexts, differentiation is usually talked about at three levels: top, middle and bottom pupils. This was not reflected in the interview data where pupils and teachers focused on the extremes: pupils of very high-ability and pupils of very low-ability. There may be something particular about mathematics that intensified a focus on the extremes. This would reflect Hoyles' (1980, p. 193) finding whereby the nature of mathematics 'gives rise to more critical situations', provoking more extremes of attitude than other curriculum areas. In using extremes pupils and teachers relied on oppositions. Having described what an individual at one extreme was like, interviewees often inverted these descriptors. In addition to prefixing descriptive terms with 'not', coding revealed quite extensive use of antonymic language.

Much of this section looks at how pupils and teachers talked about others, but it is also worth briefly considering how they thought of themselves, particularly where this changed, and potential explanations for this. My research design allowed me to identify pupils whose reported self-perceptions (within the quantitative data) changed significantly and to examine these in more depth qualitatively. One pupil who changed significantly was Sam who moved himself from a low to the lowest position. Other pupils reporting high levels of negative change would initially seem surprising. These pupils were two of three pupils moved during the year from Set 4 to Set 3. This included one of my focal-pupils, Rhiannon, who I was able to observe during the third term in her new placement in Set 3. It might be expected that these pupils' self-perceptions of their mathematical-ability would have increased with the move to a higher set due to positive reinforcement of their mathematical attainment level. However, these identified drops in ability perception may indicate the 'Big Fish Little Pond Effect' (Marsh, 1987, 2007) as these pupils have moved from being top in a small group to being bottom in a bigger group. The higher level of work became a common theme in Rhiannon's interviews and my observation notes suggest specific reasons for the difficulties encountered:

> Previously the pupils had learnt the concept of perimeter and were applying this to an individual worksheet task today, calculating the perimeter of various irregular shapes. All pupils had the same sheet. Rhiannon appeared to have a good understanding of what perimeter meant, being able to explain to me how to find the perimeter of the shapes by adding the given lengths of the sides together. She was also able to cope with shapes with missing lengths requiring her to work these out before finding the perimeter and was keeping up with the rest of the set. However, about halfway through the task she came up against this question:



> At this point she stopped working and seemed confused but also reluctant to ask for help. I asked Rhiannon if I could help. She explained "I don't know what the dots between the numbers mean."
>
> (Avenue, Y6, S3, 06.02.08)

In moving from Set 4 to Set 3, Rhiannon missed out sections of the curriculum, in this case the opportunity to gain a solid enough foundation in decimals to apply it to another area. These had not been covered in Set 4 but had already been covered and were a prerequisite to accessing the tasks in Set 3. Rhiannon was able to fulfil the learning objective of this lesson, namely to find the perimeter of various shapes, but she was unable to fully demonstrate this understanding as the task involved a missed concept. This incident suggests how strongly ability perceptions and the language used to talk about the self and others may be connected with practices. Experiences such as this may have impacted on how Rhiannon thought about herself, but also in terms of what she produced high- and low-ability to be and the language used.

Table 10 shows the uses of ability language split into high- and low-ability statements. Use of such language was high. There was slightly more use of high-ability than low-ability language. There are some between-set differences with bottom-sets tending to use more low-ability discourse and vice versa.

School	Parkview Primary School							Avenue Primary School							Across schools total
Class/set	Year 4 Class 1	Year 4 Class 2	Year 6 Set 1	Year 6 Set 2	**Year 4 total**	**Year 6 total**	**School total**	Year 4 Set 1	Year 4 Set 4	Year 6 Set 1	Year 6 Set 4	**Year 4 total**	**Year 6 total**	**School total**	
High-Ability language	19	21	36	13	**40**	**49**	**89**	28	17	65	21	**45**	**86**	**131**	220
Low-Ability language	4	19	23	20	**23**	**43**	**66**	19	20	40	32	**49**	**72**	**121**	187
Total for all ability language	23	40	59	33	**63**	**92**	**155**	47	37	105	53	**94**	**158**	**252**	407

Table 10: Pupils' use of high and low-ability language

No cell within this table is dominated by any one focal-pupil; these numbers are representative of the sets and schools shown. One difference is in the amount of language used at each school. Avenue's greater use of such language may be indicative of stronger ability discourses and practices.

The lowest use of ability predicated language, and particularly of low-ability language, was by focal-pupils and the class-teacher in Year 4, Class 1, at Parkview. This class experienced the least ability-grouping. These pupils may have been producing a less ability predicated way of understanding difference and potentially a more transformability-based mindset. This is significant when it comes to thinking about change. It is also interesting to compare what appears to be happening with this Year 4 class to the results for Year 6, Set 1 at Avenue who were subjected to the strongest ability discourses. This set produced a far higher level of such language incidences. Given that there are quite large differences even between these classes/sets and others classes/sets in the same schools, it may suggest that the individual teacher can play a significant role in changing ways of thinking, despite the prevailing discourse of the school and community. This is vital for considering change on a smaller scale and the possibility for individual practitioner action.

Based on the discussion above of extremes, I structure this discussion on the same basis, examining the language used to refer to high-ability and low-ability.

7.3.1 High-ability

The use of extremes and inverted descriptors is particularly salient in the production of high-ability. Pupils discussing those thought of as high-ability used distancing language formations: “they don’t do this”, “they’re not like this”. This language use is mirrored by pupils labelled as high-ability in explaining what they are not, often to a far greater extent than they state what they are. For many pupils it is easier to talk about the opposition; to say what something is not, rather than what it is. I highlighted this tendency in earlier work (Marks, 2007), in which pupils quickly demarcated themselves from the other; this seems to be replicated in this study:

> “If I think someone’s good at maths, I think that not only are they good at it, they like to learn and they are focussed on it and they are not messing about like some people are.”
>
> (Megan, Avenue, Y6, S1, HA, 11.12.07, Lines 26-28)

Megan uses a ‘not’ formation to explain her understanding of high-ability. Doing so develops the shared understanding of high-ability but also serves to further demarcate, distance and classify pupils along lines of ability.

Pupils often rehearsed school ability practices such as setting within their discussions, regularly justifying them through reference to innateness. It appeared that knowing an individual’s position within such a system allowed knowledge of that individual. Ability positions feed into and lead understanding, telling pupils about themselves and where they belong. Complex interrelations are set up between positioning and labelling: pupils see themselves as being in a particular position because of their label – in a top-set due to being high-ability – but see their label as arising from their position, i.e. being labelled high-ability because they are in a top-set. Pupils identify themselves and others with the label:

> “I’m a green person.”
>
> (Jessica, Parkview, Y4, Class 2, 07.12.07, Line 29)

> Peter: The bottom ones are Level 3s, the second ones are 4s then 5s and Level 6. Miss Gundry’s are Level 6, then Mr Fuller is 5 … Mr Quinton is a 4 and Mr Hockins are Level 3s.
>
> (Avenue, Y6, S4, 06.01.08, Lines 296-299)

Ben: They do tests to see how well you are doing to know where you belong.

(Parkview, Y6, S1, 21.01.08, Line 316)

The space to create oppositions may be enhanced by the nature of mathematics and stereotypical images of mathematicians. When discussing peers labelled as high-ability, pupils often talked in terms of the 'others', the pupils who found the subject not only easy, but appeared to work without effort. In setting up others as capable of effortless success, interviewees positioned themselves outside of such groups, apparently regardless of their own ability placement:

"She just knows everything."

(Catherine, Parkview, Y6, S1, LA, 14.11.07, Lines 56-57)

"He's very clever and he's good at, like Megan, he's very clever and he's good at, he's good at all round stuff."

(Natalie, Avenue, Y6, S1, MA, 04.03.08, Lines 24-25)

"She's just strong with maths in all areas."

(Miss Gundry, Avenue, Y6, S1, 16.07.08, Lines 12-13)

"She's a good all-rounder at pretty much everything that she touches or does."

(Miss Barton, Parkview, Y6, S1, 10.06.08, Line 147)

Using both descriptors and explanations, something which initially appears to be a description of what an individual can do also contains reference to that individual being able to do it because they possess some quality that allows them to do what they are described as doing. Having a high degree of knowledge, but also being able to apply this knowledge, is a particular way in which those positioned highly on the Personal Construct line were talked about:

"He seems to know quite a lot of things about maths ... he knows quite a lot of things that none of us know."

(Megan, Avenue, Y6, S1, HA, 11.12.07, Lines 58-61)

It was suggested that individuals needed to be good across all aspects of mathematics to be thought of as naturally able, particularly in assessment practices assigning one level to describe everything about a pupil. Pupils with uneven profiles would not be considered as able.

Pupils positioned at the extreme of high-ability take on an otherness within peer perceptions. This group are seen almost as not part of the rest of the mathematics class; they are somehow other worldly. The categorisation of other worldliness comes, not directly from the data, but from the literature on mathematics and mathematicians in popular culture. The data supports this theme, particularly in Year 6, with references to pupils' weirdness, strangeness, scariness, genius and bizarreness:

> Finn: "That boy who says he loves maths? He's a maths alien."
>
> (Parkview, 13.11.07)

> "I remember once I went to her house and we did our homework at her house because we had to hand it in the next day and she did it really quickly and I was on the third question, and there was like 13 questions and she just finished right away – weird!"
>
> (Olivia, Avenue, Y6, S1, LA, 30.01.08, Lines 11-14)

Although no term comes up frequently, together they represent a particular way of thinking about the highest attainers – discussed further below using the notion of the Clever-Core – which further distances them and strengthens an innateness view of mathematical-ability.

Teachers' classroom discourses, as in the previous Avenue Year 6 Set 1 extract in section 7.2.1, where a mathematical act considered at the extremes of mathematical-ability brought together the pupils' language of "scary" and the teacher's language of "genius", produce a particular culture of mathematics. The accepted ways of being in the mathematics classroom, particularly in Set 1, intensify the subject as different, and, as Boaler (2000b, p. 385) has suggested, 'weird' to pupils. This weirdness infiltrates productions of pupils who are able in the subject:

> "I think if I was asked a question on the spot and I got it right, because it would be out of the blue, so if she was like 8 × 7, and I'd be err, 56, and I'd be like, oh, I got it right, sometimes it blurts out of your mouth and other times you think 'did she say something to me?' and you think, what – it's sort of weird."
>
> (Olivia, Avenue, Y6, S1, LA, 30.01.08, Lines 107-110)

> "He's just, oohh, he's good at everything in maths, because you sort of sit there and he looks at the question for two seconds and he's 'okay, I have the answer' and you're still working it out. It's bizarre, it's just weird, he's really good at maths."
>
> (Olivia, Avenue, Y6, S1, LA, 30.01.08, Lines 36-39)

As these two extracts from Olivia show, weirdness and bizarreness appear to be linked to some quite complex, and not always understood, mathematical behaviours. Between these two extracts, Olivia labels herself, and, from the personal construct task, her highest positioned peer, as weird, but these manifestations of weirdness are different. Olivia's self-weirdness may be tied in with her belief about ability as being something within her. To her, it is the manifestation of internal ability that is weird. When she talks about the other pupil the weirdness is extended into the pupils' behaviours and becomes something visible.

The extreme pupils refer to above could be conceptualised in terms of a Clever-Core. The notion of a Clever-Core in mathematics originates from Matthews and Pepper's (2005) report into A Level mathematics participation rates for the QCA. 'Clever-Core' was put forward as a theory to explain observed low take up and high attrition rates in AS and the continuation to A Level mathematics. Matthew's and Pepper see those within the Clever-Core as pupils who are 'able' at maths, who enjoy the subject and perceive themselves as good at it. This has been further developed, debated and used by others (e.g. Bell & Emery, 2006; Bills, Cooker, Huggins, Iannone, & Nardi, 2006; Brown, et al., 2008), and more fully developed in the final QCA report (QCA, 2007). Throughout the literature, 'Clever-Core' is used to refer to those pupils with the highest levels of attainment in mathematics. Ability based practices developed under this production may amplify differences, making these differences more real. Whether or not there is such a thing as an innately Clever-Core of individuals who are somehow gifted in mathematics, thinking about success in the subject as test outcomes extenuates difference and in itself constructs a real, visible, Clever-Core.

Whilst it is possible to use the literature to explore the idea of a Clever-Core and suggest how it may develop reality in the mathematics classroom, the original literature is based on post-compulsory mathematics education, a different context from the primary classroom. It does not seem to be easy to identify the criteria for membership of the Clever-Core in the primary mathematics classroom where it is not simply about being top-set or top-table and the composition seems to change as pupils move through primary school, but they do seem to exist:

> "In my group, I'm one of, I'm like, not one of the ones who excel at maths … there's a different group of people in my top-group … the clever people … Megan, she's in the clever ones."
>
> (Natalie, Avenue, Y6, S1, MA, 04.03.08, Lines 66-67, 71, 152)

> Natalie: I think that's especially in the top-group because there's about six or seven very clever people in the class.
>
> (Avenue, Y6, S1, 03.06.08, Lines 220-222)

Where table-groups are used on top of, or instead of, setting, this impacts on pupils' productions of a Clever-Core, serving to segregate a small community within a class or set, not just by their physical placement but by the teachers' approach to them:

> Ben: But maybe [tables] 2 and 3 are quite similar. 1 is more different because they get harder questions and the teacher asks them to do a bit more. These two tables, they basically get similar work.
>
> (Parkview, Y6, S1, 21.01.08, Lines 150-152)

Here, Ben sees table 1 as 'different' as a result of the teacher's actions, but, particularly by the time pupils reach year 6, the Clever-Core seems to be a decreasing group. Placement on table 1 is not enough to guarantee being Clever-Core, and pupils view a smaller group as being exceptional in some way. This becomes evident when pupils were asked about how they would arrange the classroom; although they often reflect the teachers' grouping, they still account for subtleties within this, often stating the need for a very small, separate group "because not so much people are that advanced" (Ben, Parkview, Y6, S1, 21.01.08, Lines 204-205). Even without table-groups and an explicit demarcation of a Clever-Core, pupils see 'something' in particular pupils, perhaps reflecting Nardi and Steward's (2003, p. 359) findings in secondary school where particular students were perceived as 'frightening' because 'they just seem so clever'. The Clever-Core is not a static identity but one requiring work to ensure acceptance and maintain the balance between a cleverness held in awe and the development of an otherworldly, excluded position or the display of behaviours oppositional to a Clever-Core or even a high-ability identity.

7.3.2 Low-ability

There are similarities between the language used for high and low-ability particularly where oppositional terms are employed. However, low-ability language appears more limited, with far fewer incidents of describing peers of low-attainment in terms of their mathematics learning. The language was generally consistent, with extremes such as "dumb" and "dull" appearing infrequently. When talking about those at the lower end of the line there was greater reference to non-mathematical behaviours.

Being bad at maths and not being good at maths, whilst not always different, seem to carry their own sets of meanings. Not being good is used more frequently, reflecting the repetitive classroom discourse of 'good'. Being bad, for pupils, tends to refer to an extreme position, and is used as an opposition to good:

> Rachel: I want you to think of three children you know in year 6 …
>
> Peter: ... that are good and bad?
>
> (Peter, Avenue, Y6, S4, HA, 21.11.07, Lines 3-5)

As Peter's interruption suggests, it seems natural for pupils to think in terms of differentiating extremes but also suggests that this is where 'bad' occurs in the pupils' discourse, rather than as a term commonly used to describe the *mathematics*, as opposed to behaviours, of lower attaining peers. Megan and Natalie provide further evidence of badness being positioned as an extreme and different from not goodness:

> "I think she's not particularly bad at maths but she's not very good at maths either"
>
> (Megan, Avenue, Y6, S1, HA, 11.12.07, Lines 20-21)

> "I'm not as good at maths as Megan and Nathaniel are"
>
> (Natalie, Avenue, Y6, S1, MA, 04.03.08, Lines 45-46)

Here, as well as 'particularly bad' being seen as an extreme, there is some beginning discussion of how being bad and not being good are different. The pupil referred to by Megan is considered 'not very good at maths', but this does not automatically make her bad at maths. This is extended in Natalie's quote, where, although she self-positions as not as good as other pupils, this does not lead her automatically to position herself as bad at mathematics. It is not the case that not being good makes you bad, with not goodness representing the area before the extreme of badness.

There seems to be something less worse about being 'not good' than being 'bad' at mathematics. It seems possible to be 'not good' at specific areas of mathematics while still being good at others, although this, through reification and the pupils' understanding of levels and assessment outcomes cannot result in being positioned higher:

> "These two are really good at all round maths, anything they do they are good at, whereas Sasha, she's really good at some things, but most things she is not so good at, like, I don't think, SATs questions, I don't

> think she does very well at, and I think she's not so good at mental maths."
>
> (Natalie, Avenue, Y6, S1, MA, 04.03.08, Lines 32-35)

Sasha, despite being 'really good at some things' is not considered good at maths because she lacks all-roundness. Instead of thinking about others' strengths and the possibility for all to be good at maths, an innateness view results in Sasha being categorised as not good at maths with limited scope for improvement. Not being good can relate to specific areas of mathematics, yet the implications of this go beyond the specific, saying something about the pupil and their mathematical identity in a more far reaching way. In relating not being good to mathematics, an interesting division arises:

> "Gemma is in the third maths group, she's not particularly good at maths but she does like maths, I know that she tells me that she likes maths, she thinks it's fun, even if she doesn't get something right she will learn from it, she does like learning, she's good at learning"
>
> (Megan, Avenue, Y6, S1, HA, 11.12.07, Lines 14-17)

Megan makes a distinction between being good at maths and being good at learning. It suggests that mathematics is not something that can be learnt but something people are either good at or not. This serves to strengthen the innateness view of mathematical-ability that pupils hold and the belief that there is limited room for improvement. Not being good at maths is put forward as a statement of facts. Unlike badness, it does not convey behavioural issues and seems harder for pupils to explicitly describe.

The use of oppositions in understanding high-ability is also reflected in pupils' language use in understanding what low-ability means. Pupils' and teachers' discourse suggested productions with a focus on the extremes:

> Zackary: Our group is not extremely clever and not too extremely dumb.
>
> (Avenue, Y4, S4, 30.04.08, Line 37)

The language use and relative placement is interesting in Zackary's extract. Explaining the significance of different mathematics sets, Zackary set up extremes in much the same way as other pupils did. However, when it comes to self-placement, he does not place his own group, which by virtue of the labelling system would be the bottom extreme, at the extreme. This may have implications for how pupils are viewing the extremes. For instance, to return to the Clever-Core example, this was seen as a real group, yet membership was elusive. High-ability pupils often perceived others as better than themselves, and so the true members of the Clever-Core. The Clever-Core, to many pupils, is a real yet unobtainable extreme. It may be that something similar is happening at the other extreme of the perceived ability spectrum. Whilst others may place pupils like Zackary within the extreme they set up, Zackary and other such pupils, do not place themselves within this extreme. This was also seen with another pupil in Zackary's set:

> Rachel: Now what I'd like you to do is put a green dot on to show where Mrs Jerrett would put you on the line.
>
> Wynne: Maybe there, because I'm not extremely clever and I'm not extremely dumb.
>
> (Wynne, Avenue, Y4, S4, HA, 20.11.07, Lines 39-41)

Again, the extreme positions are presented, but Wynne does not identify with the low extreme her set places her in. Of course, as a labelled relative high-achiever within the bottom-set it may be that Wynne does not fit this categorisation. Across the study, despite there being many pupils that others would ascribe the extreme low position to, there are few pupils who would take on this position themselves, and it is perhaps only Sam, discussed in detail elsewhere in this thesis, who would take this on fully.

Low knowledge/understanding sits in opposition to high knowledge/understanding. Whilst high knowledge may place someone within the Clever-Core and these pupils may be thought about with a sense of awe, low knowledge and understanding attracts derogatory comments from pupils. Low knowledge seems to be set up as an explanation for lower placement rather than a description of pupils, yet it is also used as a justification for placing pupils lower, reflecting Howe's (1997) difficulties in the use of ability language. In addition to being used in low-placement, pupils labelled as having high knowledge and understanding use low knowledge to demarcate pupils who are not like themselves:

> The pupils are learning about coordinates in four quadrants. They are working on tasks on the Interactive White Board, some where they have to give co-ordinates of various points and some where they have to identify where a given co-ordinate would be. The teacher puts up a grid which has various co-ordinates marked which can be linked together to make various 2D shapes. The teacher asks the pupils to find a rectangle. One pupil does this quickly, saying that he has found a tilted rectangle. The teacher talks about shapes often being presented in SATs papers tilted like this to make the test harder. The teacher then asks the pupils to find a trapezium (there are several and they are fairly obvious given the grid lines). One boy quickly puts his hand up. The two higher-ability labelled pupils I am sitting next to let out exaggerated audible sniggers and in an animated conversation are quite derogatory of this boy, saying

> that "he won't get it". The teacher ignores this behaviour and the boy with his hand up, going to another labelled high-ability pupil for the answer.
>
> (Avenue, Y6, S1, 29.01.08)

Within this extract, pupils positioned as high-ability demarcate those of perceived lower knowledge in a way that enhances their status, drawing attention to what they know, through what someone else does not know. The lack of attention drawn to this incident by the teacher is striking, serving to normalise such behaviours. Not going to the pupil who "won't get it" for an answer, whatever her reason for this, gives the high-ability labelled boys, and the other set members, a sense of being right in their assessment. Whilst the teacher doesn't say anything, her actions could be taken as an acceptance of the situation and so serve, in a social-cultural understanding of identity, to co-construct with the pupils' actions and discourse an understanding of ability as something people have or do not have, and no opportunity is allowed to challenge this. Through such seemingly innocuous actions, stigmatising discourses of ability may be regularly reproduced in the mathematics classroom. This is discussed in more detail in Chapter 10.

As with the Clever-Core which brought its own set of language to describe those at that extreme – clever, excelling, weird, smart, bright – the low extreme also brings its own set of language:

> "Probably because times tables are quite big in maths and if you don't know your times tables you're probably quite, not rubbish, but [laughs]."
>
> (Emily, Parkview, Y6, S2, MA, 14.11.07, Lines 61-62)

> Uma: I know someone who left and she used to say to my friend and her friends I'm better at you than maths and you're rubbish, you're completely dumb.
>
> (Avenue, Y4, S1, 06.05.08, Lines 130-131)

> "She's not as dire as some."
>
> (Mrs Jerrett, Avenue, Y4, S4, 16.07.08, Line 13)

> Rachel: So what are the table-groups?
>
> Sam: It's like the dodgy people all together.
>
> (Avenue, Y6, S4, 06.01.08, Lines 82-83)

Importantly, this language is used across ability and year-groups and employed by pupils and teachers as a normal way of talking about pupils perceived to fall within this low extreme. This language use was more limited than the use of Clever-Core language. Across the focal-pupil interviews there were 14 uses of derogatory language at Avenue and one at Parkview. It is only possible to say from this that there is a school difference rather than attribute this to any ability practice although, as seen in the interview extracts above, such language was at times used specifically in relation to ability practices. There appears to be some difference in how much this language is used dependent on set placement with those in the bottom sets using twice as much low extreme language than those in the top sets. Interestingly, much of this usage was not in self-placement or description but in talking about the extreme they, as much as the high-ability, distance themselves from.

Earlier I showed how ability is predominantly thought of as an internal innate quality. Such a view is important within the language of low-ability. A key way in which low-ability language differs from high-ability language is in reference to learning difficulties and associated support needs. These are spoken about solely in relation to the lower extreme. Table 11 shows the use of language naming and discussing learning difficulties as a reason for pupils performing poorly in mathematics.

		Avenue Primary	**Parkview Primary**	**Total**
Year 4	**Mixed-Ability**		0	0
	Top-Set	6		6
	Bottom-Set	7		7
Year 6	**Top-Set**	1	1	2
	Bottom-Set	6	0	6
Total		**20**	**1**	**21**

Table 11: Pupils' references to learning difficulties in explaining low-ability

These data come from the same number of interviews and observations for each school. There is a marked difference in the use of this reasoning between the schools, with Avenue pupils using such discourse far more than Parkview pupils. This may reflect the inclusive nature of Parkview or may say something about ability, assessment and secondary selection practices at Avenue and the impact of these on pupils' beliefs.

Whilst this study suggests pupils produce an understanding of mathematical-ability revolving around innateness, a difference emerged in how pupils 'innately good' and 'innately bad' were discussed. Whilst those who were good were discussed in an innate manner without the need for explanation – it was just something they were – those discussed as innately bad, and this was a small group at the extreme, were additionally discussed in terms of what it was that made then innately bad. In effect pupils seemed to be able to justify innate badness in a way they could not justify innate goodness, with a high degree of similarity in how low-attainers were described or self-described:

> "Well I think he's very smart, he's smarter than me because I'm dyslexic."
>
> (Zackary, Avenue, Y4, S4, LA, 20.11.07, Lines 9-10)

This extract from Zackary's Personal Construct Interview is typical of many interviews. Dyslexia or learning difficulties were seen as justification for not doing well. Such reasons strengthen an innateness view of ability giving pupils a plausible reason for not having the innateness they talk about others having. This use of labelling is further highlighted by the non-labelling of pupils in top-sets. Here, pupils experiencing the same difficulties refer instead to unspecified difficulties:

> Olivia: I'm always writing 6 and looking at it upside down and thinking it's a 9 because there's something wrong with me, but you can't call someone bad at maths because they slip up on some questions.
>
> (Avenue, Y6, S1, 29.04.08, Lines 239-242)

These same difficulties may be labelled specifically in bottom-set pupils, yet in the top-set, they are left unspecified. One reason for this may be an assumption that appeared to run through pupils' and teachers' interviews that learning difficulties only applied to pupils of low-ability. Further, mathematical behaviours required for a label of high-ability/good at maths were seen to sit in direct conflict with labels of learning difficulties:

> "Well he's there because he has learning difficulties"
>
> (Peter, Avenue, Y6, S4, HA, 21.11.07, Line 14)

> "Well there used to be this boy in our class, who I think, I'm not sure, I think he was dyslexic or something, he had some kind of problems, he would be about there but not down there, he does know maths, he does know how to add and stuff like that and times tables, but he doesn't really know that much because he's got some problems with him."
>
> (Abbie, Parkview, Y6, S1, HA, 27.11.07, Lines 88-92)

In both these cases, Peter and Abbie justified their placement of pupils lower down the line on the basis of learning difficulties. This was seen as the only, and unchallengeable, reason needed. Knowing enough mathematics to be considered good at the subject is viewed as incompatible with having such difficulties, and having such difficulties precludes higher-set placement. This relationship seemed so strong that where pupils were faced with contradictory evidence, they were unable to reconcile this other than through reference to a "miracle":

> Sam: Well, no, not being rude or anything, but Alfie, you've seen Alfie haven't you, he's got like, he's got like problems a bit, a tiny bit mental, he's not well and like the thing is no one can expect him to get such a good mark in any SAT paper and people think he'll probably get 2 – 3 at the max, he beat three people, three clever people he beat and everyone just looked at Alfie and thought hang on, we thought that he's not that well, not that good at maths and look what he's got, he's got a 19, we all, that day we all thought a miracle had happened, because it's meant to be the cleverest get first and the lowest get low scores, but he just went from zero to 19, bang!
>
> (Avenue, Y6, S4, 04.06.08, Lines 63-71)

There is a distinction involving extremes with specific difficulties being related to a low positioning and resultant low expectations. It appears that these are accepted and expected by all pupils through the recount of events whereby "everyone just looked at Alfie" and the deviation from what is 'meant to be' strengthens such beliefs.

Similar views were seen in the teachers' interviews with a suggestion of a link between low positioning and learning difficulties which preclude high-ability mathematical behaviours. There appeared a sense that any pupil with identified needs would be, by default, weaker at mathematics:

> Rachel: So extending that, what sort of things would make a child not so good at maths?
>
> Mr Iverson: Lack of parental support so they don't practice maths at home, poor self-image, poor reading skills, reading is a very

> crucial factor in a lot of, particularly in terms of understanding, poor auditory skills, maybe a specific learning difficulty, or where visual or hearing are not as strong, lower concentration skills, just haven't developed as much … very weak children with learning difficulties who are never going to get it, never going to progress up.
>
> (Mr Iverson, Avenue, Y4, S1, 16.07.08, Lines 67-72, 89-90)

> Mrs Jerrett: Again, things like, well being dyslexic, poor sequencing, poor memory, you know some children have a very weak short term memory some have a weak long term memory, so they know it might be there but they can't remember it, not a very good visual memory for setting things out, shapes, and picturing the number square or the hundred line and which way do you move, left or right and getting bigger or smaller, all of those things I think impact down here.
>
> (Mrs Jerrett, Avenue, Y4, S4, 16.07.08, Lines 72-77)

These two extracts show similar opinions across the Year 4 sets. The same was also seen with year 6 teachers at Avenue, but, as with pupils, there was less use of such language at Parkview. These teachers explicitly mention learning difficulties as a justifiable reason for doing poorly in mathematics, positioning such pupils at an extreme as exemplified in Mr Iverson's extract where he suggests that these pupils are "never going to progress up". Similar views were seen to dictate practices, as observed in a Year 6, Set 4 lesson at Avenue and then rationalised by the teacher:

> During the lesson the pupils were working on addition with various sheets given to different pupils. Andrew had been given single digit calculations which he completed quickly with ease and accuracy before walking to the teacher's desk, taking a sheet involving 2-digit addition and beginning this with ease. Mr Leverton took the sheet back from Andrew and gave him another sheet involving single-digit addition. Andrew reacted very angrily to this; his behaviour was ignored by the teacher but not by the other pupils. After the lesson, Mr Leverton wanted to justify his actions stating "He's a weird boy, he has Asperger's, he's very stubborn and won't see the lesson my way, he thinks he can move on, but of course he can't."
>
> (Avenue, Y6, S4, 30.01.08)

There may have been justifiable reasons for this level of work but these were not communicated to Andrew and the subsequent behavioural responses were interpreted negatively and as evidence of his labelled ability. As with Mr Iverson, Mr Leverton held a belief that a label of SEN was incompatible with progress, firmly rooting SEN within low-ability language. The language used during these and other exchanges, exchanges which were with individuals or small groups but audible to the whole class/set, possibly strengthened pupils' productions. In the following extract the Year 4 mixed-ability class at Parkview was being taught by the Year 6, Set 2 teacher who had immediately put the pupils into ability-groups. The lesson consisted of recapping subtraction methods and at this point in my observation, the pupils were being taught as a whole-class to use a number line to count up:

> The teacher has now been through the method three times. She explains that she is going through it once more and that this time she wants the pupils to be sure of the different parts they need to write down when they do their questions. She gives them the (uncontextualised) question: 56 - 12. Without asking the pupils she says that the first step is to draw a number line and put the numbers on it. She does this on the IWB:
>
> 12 56
>
> She then tells them that they need to do the sum on the line, doing this without further explanation on the board:
>
> +8 +10 +10 +10 +6
>
> 12 20 30 40 50 56
>
> She then tells them that they must not leave it there but must do the sum underneath, writing this out for them:
>
> $$\begin{array}{r} \mathbf{30} \\ \mathbf{6} \\ \mathbf{8} \\ \hline \mathbf{44} \end{array} \quad \mathbf{=} \quad \begin{array}{r} \mathbf{30} \\ \mathbf{14} \\ \hline \mathbf{44} \end{array}$$
>
> The teacher explains that this is the last stage and that she expects to see all the stages in their books. She then turns to the low-attaining group and explains to them (so all other pupils can hear) that they might find it difficult to remember the different things to include. She suggests that for each question they follow her example on the board. This suggestion isn't made to other pupils.
>
> (Parkview, Y4 [taught by Y6, S2 teacher], 01.02.08)

There appear to be implicit assumptions that the group of pupils specifically addressed are more likely than other pupils to find it "difficult to remember the different things to include". Importantly, the teacher does not talk about the mathematics being difficult; the difficulty here relates to the process and to the inclusion of the stages required for the recording of the work. Highlighting this potential difficulty *whether real or not* may intensify beliefs about pupil difference.

7.4 Chapter Conclusion

The pupils discussed here were, as Boaler (2000b) suggests, not only learning mathematics, but learning to be a mathematician. They were observed engaged in processes of producing understandings of mathematical-ability that are likely to be carried forward into and beyond secondary mathematics. Through the seemingly innocuous actions of teachers in the primary mathematics classrooms, the basis for these discourses appears to be being developed. Pupils produced similar stigmatising discourses of ability to those found in everyday use. These productions are strong in Year 4 and particularly salient in Year 6 where assessment practices may strengthen and justify pupils' beliefs about mathematical-ability. This mirrors the 'evolving sense of ability identity' found in Hamilton's (2002, p. 601) secondary school study.

Pupils' models of ability portray a stable concept with little plasticity. These models can be complex, drawing on multiple ways of thinking including internal and external references. However, the overriding view of mathematical-ability is as an innate, genetically determined quantity, residing within individuals in specific quantities, with limited possibility for change. Pupils' models and language were predominantly located at the extremes. High-ability involved effortless success and all-roundedness in mathematics but was also tinged with a discourse of weirdness and other-worldliness. An extreme group within those deemed to be high-ability were thought of in terms of a Clever-Core, although entry to this group was deemed unattainable to most, with pupils identifying peers who were more able than themselves. Low-ability productions tended to focus more on behaviours and relied on a limited set of sometimes derogatory language. Additionally, extreme low-ability productions made repeated use of special educational needs both as a rationale and justification for ability placements and labels.

This chapter has examined pupils' productions of mathematical-ability, addressing specific aspects of the research questions. The following chapters extend this, looking at how ability is experienced, and as such reproduced, within the primary mathematics classroom.

8 Common Ability Practices and their Impacts in Primary Mathematics

8.1 Introduction

The previous chapter explored pupils' and teachers' productions of ability in primary mathematics. Many of these productions stemmed from, or informed, practices. The most common, and perhaps most explicit, of these practices – ability-grouping, setting and streaming – are well documented, particularly in the secondary mathematics literature. As noted in Chapter 3, less is known about the primary context, particularly in relation to multiple effects.

In this and the following chapter I consider the impacts of ability practices for pupils at Avenue and Parkview. This chapter focuses on these practices directly at a level often considered in the literature. It takes each form of ability-grouping experienced by the pupils and asks what the impacts of these practices are on teaching and learning. Additionally, this chapter also examines a further explicit practice of ability – that of secondary selection – which has impacts for how primary pupils see themselves now and for the sedimentation of ability productions as they move from primary into secondary education. The qualitative data presented in this chapter extends (and goes beyond) some of the potential quantitative associations identified in chapter 6. In particular, understanding the impact of ability practices for pupils at Avenue and Parkview may add to an understanding of pupils' differential levels of enjoyment as reported in section 6.3. The following chapter considers the less obvious, more implicit, impacts of ability (within and beyond grouping). Although consequential practices occur concurrently with the more explicit impacts of ability, the two are considered separately for clarity in the analysis.

8.2 Pedagogy in Sets (Between-Class Grouping)

Associations in the quantitative analysis, particularly in terms of attainment outcomes and educational triage as reported in section 6.2.2, may suggest, through differential outcomes, differences in the teaching and learning experiences in each set. For instance, the evidence of attainment gap widening as a result of educational triage indicates different learning experiences within Sets 3 and 4, further evidenced through the finding of reduced ability-perceptions for specific pupils moving from set 4 to set 3. Different beliefs about the causes of success in each set, particularly the higher competitive beliefs in Set 1, Year 6 classes in at both schools, also suggest something different happening within each set.

This section examines the teaching and learning experiences within each focal-set through the qualitative analysis. This will enable an understanding of how the 'unequal distribution of knowledge in schools' (Oakes, 1982, p. 111) occurs and is maintained through setting, and how this potentially results in the differing quantitative outcomes. I look at the differences in teachers' approaches – and pupils' reactions – to top and bottom ability labelled sets, exploring the general characteristics of top and bottom-set lessons.

8.2.1 'Top-set' teaching and learning

During the 2007-2008 academic year I formally observed 36 setted lessons at Avenue and Parkview (Year 6) within my focal sets in addition to further unplanned observations of both focal and other sets. From this experience I would suggest that top and bottom sets had a very different feel and a number of different characteristics. In this section I use my observations alongside interview data to present a picture of top-set mathematics lessons, drawing out characteristics which may lead to different outcomes.

The style and characteristics of the top-set lessons observed reflects many of the characteristics of top-set secondary school mathematics discussed in the literature. In particular, many lessons were focussed on procedural learning and the application of methods. Pupils learnt to apply methods without questioning, with the focus being on attaining the correct answer rather than developing understanding. Teacher talk was often based on transmitting procedures and lacked explanation. On no occasions during the observations of top sets were pupils seen to ask 'why'; they appeared to accept a view of mathematics as methods, and worked through the memorisation and application of these without question. This is likely to strengthen pupils' productions of what mathematics is and what it means to be mathematically able, further heightened by teachers' references to the need for pupils to be disciplined and methodical in their approach to the taught methods.

Pupils were expected to display ease in the application of methods. In some cases it appeared that a focus on understanding was included within the lesson, yet this often proved to be superficial. For instance, in the Year 4 top-set at Avenue, pupils were often asked what different terms, for instance partitioning, meant, yet there was a shift from ‘what’ to ‘how’ in pupils’ responses. ‘How’ answers were accepted by the teacher and appeared to be the sought response, with the ‘what’ left unanswered. There were cases where things were different, although these were unusual and often represented tangents to the lesson:

> The lesson is recapping previous work on area. Pupils are presented with a rectangle on the board with measurements of 7cm and 9cm. They are first asked what area is. Many pupils appear to have heard or reworded the question as ‘what is <u>the</u> area?’ as questions within the class are generally asked in relation to specific questions and methods and they seem to be working out the answer. The first pupil the teacher asks answers that it is 7 x 9 = 63. He does not give any units. The teacher replies that this is a ‘how’ answer and not a ‘what’ answer, leading into a further discussion about the meaning of area, before the teacher returns to a more procedural approach for the remainder of the lesson with pupils working through multiple examples from the board.
>
> (Avenue, Y4, S1, 11.12.07)

This type of discussion was quite rare and highly controlled by the teacher. Even in this example, the teacher was looking for a specific answer to his ‘what’ question rather than opening this up to discussion. In a previous lesson the teacher had provided the pupils with a way of remembering the concept of area and he was looking for a recall of this.[11] It is particularly salient that where discussion and asking ‘what’ questions did occur, the lesson content was usually of a more practical nature involving work on, for instance, shape. During my observations, no ‘what’ discussion was seen in the context of number-work. This lack of focus on understanding may not be reflective of the set placement. Discussions of this type were absent in the bottom sets observed, and the limited discussion and teaching for understanding may be more reflective of individual teachers than setting practices.

Alongside, and perhaps a feature of, procedural learning, top sets were observed, as repeatedly referred to within the literature, as dominated by a fast pace, high-speed in working and a race towards producing as many answers as possible. Speed appeared to be highly valued. Pupils were regularly given time prompts to keep them working quickly and

[11] The explanation the set-teacher was looking for was that area meant the inside of a shape. He was looking for this explanation in order to ensure pupils could differentiate between area and perimeter. He provided pupils with a mnemonic to remember this. He explained that ‘area’ sounded like ‘Ariel’ (laundry detergent) and that as Ariel went inside the washing machine, area referred to the inside of the shape.

were praised for responding to this, in many cases regardless of the content of their work. Within lessons, teachers highlighted speed as a positive behaviour:

> The teacher states for the whole class to hear: "I notice that Simon is on question 6 already". At this, another pupil says that he is on question 7, another that he has finished, and a competitive discussion erupts.
>
> (Avenue, Y4, S1, 11.12.07)

> During the lesson, pupils on the top-table were having a race with each other to see who could complete the most questions. When the teacher came to see what they were doing, they explained that they were racing, and without looking at their work, the teacher said that this was good.
>
> (Parkview, Y6, S1, 27.11.07)

In the Parkview example the seven top-table pupils in the top-set had verbally agreed at the start of the task – a series of number based multiplication questions using the grid method – that they would race each other through the questions and see who could finish first. Each pupil was individually engaged in their work with what appeared to be the aim of finishing the task rather than correctness. A number of calculation errors were observed, and in prioritising speed, inefficient methods were used (Figure 8).

	1000	000	40	0	
700	700000	0	28000	0	728000
00	0	0	0	0	0
3	3000	0	120	0	3120
					731120

Figure 8: Grid multiplication application – Parkview, Year 6, Set 1

When the teacher came to see the work they had done, it seems likely that she took the quantity of work as evidence that they understood. There may also have been an assumption that these pupils would be able to do the task set as at no point did she check their work or discuss efficient ways of working. Praise instead was given to the behaviour – racing – which the pupils drew her attention to. Likewise, in the Avenue data extract, pupils were encouraged to work quickly, over, perhaps, working precisely, with a competitive atmosphere positively encouraged. Incidents such as these were very common, with the work of one pupil drawn attention to as a positive example for others to follow. However, it was often not the mathematics at the centre of the praise, but a learning behaviour, in this case, speed of working. The competitive discussions that often followed such teacher comments were frequently limited to the Clever-Core; in some cases it appeared that the teacher was very deliberate in the choice of pupil and their current work place so as to ensure that such a discussion, which was short-lived and highly controlled by the teacher, *did* occur. These discussions were audible enough and just long enough to engage the attention of the majority of set members, both adding pressure to them to work more quickly and highlighting aspects of the teachers' production of a high-ability identity.

Pace was also reproduced through the teachers' actions; within top sets and in contrast to bottom sets, there was a distinct lack of wait time given by the teachers after asking a question. Quick, concise responses were expected. Where pupils appeared to be thinking about their answers, teachers often redirected the question at another pupil. Top-set classroom language was dominated by a discourse of speed – whizzing on, working quicker, storming ahead, getting lots done etc. – a discourse which appears to be integrated into pupils' ability productions. Such a dominance of pace is likely to impact on the types of mathematics and ways of working made available to pupils. In their interviews, pupils discussed wanting the opportunity to talk to others about their work, to share ideas and explain concepts to peers:

> Megan: When it's class-maths, some of the boys who are like lower down like, they say like can you help me once you've done your work, but then you're trying not to end up doing it for them because then they just think oh yeah you can do all of it.
>
> Natalie: That's quite difficult, but it's nice knowing that you've helped somebody accomplish something and I think it helps you understand how other people's brains work.
>
> Megan: And it helps you to explain like then you'll know how to explain it, because if you needed to explain something to someone then you'd understand how to do it if you needed to explain to someone of your age something that they didn't understand.
>
> (Avenue, Y6, S1, 03.06.08, Lines 172-180)

This interview extract came up when the pupils were discussing class maths where they are taught in their usual registration forms rather than sets and the perceived benefits, as they saw them, of this way of working. Although Megan suggests some potentially problematic aspects to class maths – some pupils doing all the work for others – she talks about valuing the opportunity to talk to others, and how the process of explaining the work so that others understand aids her understanding. This would seem beneficial both to Megan and to other pupils, but it is difficult to see how such processes could occur in top-set lessons where pace and procedural learning lead pupils towards seeking a 'sums and answers' approach.

Top sets were observed to be very competitive environments with pupils working to maximize their advantage. Teachers' actions intensified this environment, built on a belief that a competitive approach was beneficial to, and what the pupils wanted:

> "I think as well, I think particularly in the top-set, the children enjoy in some ways the challenge of improving their levels and I think they're quite, because they're confident, because they're, to a certain extent, a lot of them are a bit competitive, that's how they work best."
>
> (Miss Gundry, Avenue, Y6, S1, 16.07.08, Lines 116-120)

Here, Miss Gundry suggests that pupils work best within a competitive environment as it matches their orientations towards learning as she perceives them. This perception seems intuitive, particularly when observing how her Set 1 pupils engage in lessons. However, suggesting them to have a competitive approach does not fit the quantitative data. Although Parkview Year 6, Set 1 pupils reported higher competitive beliefs than Set 2 pupils, their prominent reported beliefs were Interest & Effort and Understanding. However, regardless of the pupils' actual beliefs, they are treated as having a competitive belief. This may underscore the teachers' actions whereby she encourages some discussion of quantity of work completed and a classroom environment where pupils are constantly trying to complete more than others.

One outcome of a competitive environment is that pupils were self-interested rather than concerned with working cooperatively. Pupils were working for themselves to be better than others. Hallam and Ireson (2006) suggest that peers are more supportive of each other in higher ability-groups compared with lower ability-groups but I would suggest from my observations that these peer relationships are qualitatively different; one is not more supportive than the other – both may be unsupportive – but top-set peer relationships appear to be more nuanced and subtle in being unsupportive. In particular, I noted incidences within the observations conducted whereby pupils turned to each other for support, but the competitive fast-paced nature of the classroom led to this support being denied:

> Having quickly completed the 2-digit sums on the board, Abbie and her partner are making up sums for each other at the request of the teacher with 'bigger numbers' – the teacher saying this will make it harder. Big numbers and speed are clearly being valued – the girls are working in

> competition against each other to finish the procedure first. Whilst they are in competition, another pupil from the adjacent table asks Abbie for some help, but Abbie refuses saying she can't help because she needs to finish before her partner.
>
> (Parkview, Y6, S1, 14.11.07)

> Olivia: I know, because if you say I'm stuck on this one they're like oh my god that's easy but they don't help you or anything they carry on with what they are doing because it's almost like, for them, a race
>
> Megan: Yeah to finish first
>
> Olivia: And Miss Gundry always gives them loads of praise and a team point, like this morning I asked Matthew how to work something out and he's like just, you just multiply it, and I'm thinking great, that's really helpful.
>
> (Avenue, Y6, S1, 29.04.08, Lines 247-252)

In the lesson observation and interview extracts above, the implications of a competitive ethos are discussed. In the lesson observation, Abbie, the high-ability focal-pupil in this set, refused to engage in cooperative behaviours and help another pupil, who at other times she was seen to be friendly with, because this might have resulted in her producing less work than her partner and weaken her ability identity. The performed identity is so strong that in this case it, at least momentarily, overrides other aspects of Abbie's identity. A similar incident is recounted by Olivia but in this case she is the pupil asking for support. She talks first about how others perceive the work as a race and then discusses the effect of this when she asks a peer for help. Although help is not completely refused as in Abbie's case, Matthew gives Olivia an answer which is unhelpful in allowing her to move forwards with her work, allowing him to return to his work and the assumed 'race'. Later within this group-interview, Natalie explains how this lack of peer support arises:

> Natalie: But the thing is with maths is that I think a lot of people think that it's just, well not think, but they know in their heads that Miss Gundry, if you help someone, you're less likely to get a quality mark[12] than if you do good work or if *you* improve, but if you're struggling you expect more from you so they just carry on with their work and just say something like multiply it and that doesn't help.
>
> (Avenue, Y6, S1, 29.04.08, Lines 311-315)

[12] Quality marks were merit marks awarded to pupils, by teachers, at Avenue Primary. They were written onto their work and collected up for certificates given out in achievement assemblies.

Natalie's extract suggests how competitive behaviours are privileged by the teacher and responded to positively in terms of praise and reward. Pupils are rewarded for focusing on their work rather than being supportive of their peers. She goes on to note that this results in dismissive responses similar to Matthew's response to Olivia. This extract suggests how teachers and pupils may work together in co-constructing the nature of the top-set mathematics classroom as competitive, fast-paced and predominantly concerned with procedural working and the production of answers over understanding, something which is explored further in Chapter 10.

8.2.2 'Bottom-set' teaching and learning

Whilst top-set lessons were, in general, found to be characterised by fast pace, competition and an at least superficially mathematical approach, bottom-set lessons in Year 4 at Avenue and in Year 6 at both schools were observed as qualitatively different environments. As with top sets, the differences experienced by those in the bottom sets are widely reported in the literature:

> '[I]nstructional practices were distributed among tracks in a way that students in the lowest group were the least likely to experience the type of instruction most highly associated with achievement. And, if students in low tracks had consistently less exposure to effective teaching practices, it seems likely that their access to achievement was not equal to that of students in classrooms where these practices were more often found.' (Oakes, 1982, p. 114)

Based on US tracking, Oakes suggests there are qualitative differences in teaching approaches in high- and low-ability-groups which may impact on the pupils' achievement. In addition to achievement effects, the differences in teacher approach may lead to actual and perceived differences in the classroom learning environment, with Callahan (2005) noting that for pupils in the lowest sets, their access to supportive learning environments is likely to be limited. Teachers in the lowest sets have been found to make the greatest use of teaching materials such as manipulatives (Oakes, 1982). This fits with data from the teachers' interviews, whereby they repeatedly talked about the need to use a hands-on, kinaesthetic approach with lower-ability pupils. This was particularly the case with Year 4, Set 4, at Avenue where the teacher often carried around vast amounts of equipment to ensure that her pupils had access to the manipulatives she deemed necessary to complete much of the mathematics taught. In the majority of lessons, these pupils were expected to use apparatus even if they could carry out the mathematics without it, for instance using cubes for single-digit addition. Apparatus use was expected even where it created greater confusion through providing additional representations (cf. Houssart, 2004; Seeger, 1998). Further, requiring pupils to use manipulatives restricted their opportunities to learn to work from derived facts, resulting in them doing more, harder mathematics, whilst their progress is limited (Gray, 1991; Gray & Tall, 1994). It should be noted that these representational and restrictive implications were unlikely to be recognised by the teacher, with the teacher acting to support pupils through the requirement to use manipulatives.

A key difference observed in bottom sets across schools was the greater focus on behaviour and the high incidence of behavioural reprimands. Whilst these were not entirely absent in top-set lessons or in the mixed-ability classes at Parkview, their use was usually brief in comparison to what happened in bottom sets. Further, the behaviours which were drawn attention to and acted upon were wider in these sets, with many of the same behaviours apparently ignored by top-set teachers. The need for teacher control seemed stronger in bottom-set lessons, not just in the mathematics, but also in controlling pupil behaviour. Pupils in bottom sets talked strongly and repeatedly about the behavioural focus of their teachers, reflecting what was observed:

> Peter: There are a few teachers what are stricter than others
>
> Sam: No but literally…
>
> Peter: He goes too far.
>
> Sam: Too far, Elizabeth was about to cry and he literally slammed the table and we all thought he was going to hit her.
>
> Peter: Once he slammed the table and I fell off my chair and I hit my head well badly.
>
> Rhiannon: I remember – you were crying.
>
> Peter: It was well scary.
>
> Sam: He was like proud of himself.
>
> Peter: It was literally inches away from my face, he had his fist too like [hits fist onto table].
>
> Sam: It's true, if we want to talk, he doesn't let us talk. Like me and Saul, we always sit together because we're mates, and I ask him about a question which I don't really know, and Saul tells me the answer, but Mr Leverton gets annoyed and says, "you go and sit over there on your own and do what you want", but then Saul tries to explain that he was trying

> to help me but Mr Leverton doesn't listen, won't let anyone speak. He's an idiot.
>
> (Avenue, Y6, S4, 06.01.08, Lines 31-47)

This discussion came up in the group-interview when I asked the pupils about differences between mathematics groups. Rather than focus on mathematical issues or individual difference as pupils in other interviews did, Rhiannon mentioned it being 'just like good for the teachers' before the focus of the discussion turned to behavioural issues. The vivid and spontaneous recounting of this incident suggests that it was something important to these pupils and that it had an impact beyond the lesson in which it occurred, potentially integrated within the pupils' productions of what it meant to be in the bottom set. At the end of this extract, Sam talks about the behaviour response of the teacher continuing when he asks another pupil for support with his mathematics. This gives an example of treatment being different for pupils in different sets: where pupils were observed asking for peer support in top sets, this was rarely seen as a poor behaviour by teachers and in some cases was actively encouraged; it was the peer response in top sets where the least supportive behaviours lay.

Evidence supporting the above discussion was seen in lesson observations. In one observation, Sam and Saul were heavily chastised for talking, despite their talk being mathematical and interesting in nature. In an interview shortly after this lesson, Sam talked about the impact of having mathematical discussion limited:

> "That affects my maths, because if I was going to ask a question, he wouldn't allow if, if the question is part of my work then he still won't allow it"
>
> (Sam, Avenue, Y6, S4, LA, 04.03.08, Lines 51-53)

During the lesson, Sam had asked Saul if dividing by two meant he was supposed to put the counters he had into two groups or into groups of two. Saul had, to this point, been putting counters into two groups but was now trying out both ways and this seemed to cause some confusion to the boys who were discussing which method they thought they should be using. This was quite an animated discussion and the noise was interpreted by the teacher as non-mathematical with both boys disciplined for talking in class, despite others being allowed to talk freely. It appears that the behavioural focus of the bottom-set may have led the teacher to immediately respond in behavioural terms rather than consider that there may be a mathematical basis to the discussion. This then limited the possibility for mathematical discussion either between the pupils or between pupils and teachers and may have impacted on mathematical identities, engagement and attainment.

The findings above concerning behaviour strongly reflect the existing literature, with similar findings consistently found over many years:

> '[T]rack levels differed primarily in the amount of class time teachers and students reported was spent on behavior and discipline and in students' perceptions of their teachers as concerned or as punitive … Students in low-track classes saw their teachers as the most punitive and least concerned about them. Teachers in these classes spent the most class time of any of the groups of teachers on student behavior and discipline.' (Oakes, 1982, pp. 114-116)

Oakes' analysis showed that teachers were spending more time engaged in behavioural interactions in lower sets and that pupils picked up on this and reported it within their perceptions about their mathematics classes.

An additional factor to come out of the high behavioural focus in bottom-set lessons was that, as Sam referred to previously, mathematical discussion was limited. Again, as discussed in looking at the procedural approach in top-set lessons, this was not always highly evident in top sets either, but the lack of such talk and the reasons for it appeared to be different in lower sets making it even less likely to occur. In a later individual interview, Sam brought up the same issues he previously discussed in the group-interview:

> "I don't really know, he thinks me and Saul are like always bad, but we're not sometimes bad, like if I get stuck on a question I ask him, Saul, what's this, and he'll think we're talking, he doesn't even let us speak, we say 'he's trying to help me', but he doesn't let us speak, that's what the frustrating thing about him is, that's why no one wants him to be our teacher … I've noticed every time the girls sit next to each other Mr Leverton doesn't say anything, but every time me and Saul sit together, we don't even talk, we're just sat next to each other and it's 'Oh Saul, go away, go and sit on another table' and when Saul goes away I get stuck on my maths, because normally Saul helps me a lot because he's really good at maths, he doesn't tell me the answer, he goes look, this add this is this, he no way tells me the answer, he really helps me to get it myself, but Mr Leverton, is 'No, go away do it yourself'. It's frustrating sometimes."
>
> (Sam, Avenue, Y6, S4, LA, 04.03.08, Lines 20-24, 55-61)

In this extract, Sam was talking about differential treatment experienced within the set, but his discussion is still relevant in understanding bottom-set teaching and learning. Whilst Sam identifies the potentially positive role peer discussion could play in developing his mathematical understanding, his recall of the teacher response reflects lesson observations where pupils were usually expected to work alone. Talk, particularly when involving the pupils labelled as lowest within the set, was immediately viewed as a poor classroom behaviour. Unlike the lack of peer support in top sets, Sam's frustration comes directly from the teacher. In effect, all pupils appear to be limited in terms of peer support but the origins of this are different, coming from peers in top sets and teachers in bottom sets.

In addition to being limited through poor behavioural expectations and teacher control, discussion also appeared restricted in bottom-set lessons as a result of teachers holding a view of mathematics as having only one correct answer, with this being evident in lesson observations and a stance to which teachers eluded in their interviews:

> "I think they have a bit of a fear of, in maths it seems like you have to get, there's a right or wrong answer, but in literacy it's not quite like that you can have your own ideas, and I think there's a fear of getting things wrong and perhaps, you know, in the old days being a bit humiliated in front of everyone, I remember when I was at primary school, if you didn't know the answer, or, I couldn't remember, different things would happen where you'd be stood up in front of everyone in quite a horrible way so it became a real fear and I think it does go back a lot to the kinda right or wrong answer."
>
> (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 57-64)

> "Literacy is emotional based, you know, how do you respond to this character, how does it make you feel, so it's maybe, we're saying that we all have emotions that are equally valid, we can all think that was good or bad and give a reason for it, but for a maths question it's often the right approach or the wrong approach, for lots of things, not for everything; except for investigational things."
>
> (Mrs Jerrett, Avenue, Y4, S4, 16.07.08, Lines 177-182)

Pupils alluded to the same principle in their interviews, making comparisons between mathematics and Literacy/English. Abbie, for instance, talked about the range of acceptable responses when writing a story but appears to suggest that there exists a right way of doing mathematics in her reference to having to get used to it:

> "In English you can just write a story and you might not be very good but it could turn out to be a really good story but in maths you just have to get the hang of it and you have to know quite a few things and understand what everything means and everything but in English you can just write a story, you don't have to, well you can get the hang of a story really easily."
>
> (Abbie, Parkview, Y6, S1, 27.11.07, Lines 42-46)

With the teachers potentially seeking only one correct answer, classroom discussion is immediately restricted and closed, becoming about answers rather than approaches and understanding. Miss Barton talks about the fear some pupils feel in mathematics and refers to her own learning experiences. Mrs Jerrett spoke, in a further section of her interview, about a fear of mathematics and the need to protect pupils from this. It may be the case that teachers are actually reproducing this fear for the pupils through their actions intended to protect the pupils and maintain tight control.

A view of mathematics as dominated by one correct answer, in addition to a fear of any other approach and a potential loss of control, appears to result in severely limited learning experiences and a lack of opportunity to engage with the mathematics which is already simplified and limited in response to the pupils' perceived need to be protected from 'hard' mathematics. For bottom-set pupils, some of their teaching and learning experiences, for instance a heavy reliance on answers rather than understanding, may be similar to the experiences of pupils in top sets, but these experiences are intensified by the perceived need for high levels of control both over behavioural factors and the actual mathematics the pupils are exposed to. There seems to be an uneasy conjoining of a punitive – in terms of strong behavioural control – and protective – in terms of restricting access to 'hard' mathematics – approach to bottom-set lessons. Both are restrictive and, in the pupils' words, frustrating, potentially leading to limited opportunities for engagement, widening the attainment gap and producing and reproducing very limited mathematical identities.

8.2.3 Transition: Moving from mixed-ability to setting in year 6

The moderate setting at Parkview proved to be fortuitous in understanding what happens in primary mathematics classrooms as a result of a dominant discourse of ability. Here I had access to pupils who had previously experienced a predominantly mixed-ability approach, involving within-class grouping at the most, for the first six years of formal schooling (Reception to Year 5) but who were then placed into sets for mathematics in the final year of primary school. I followed these pupils over the year as they developed their understanding of setting. As these pupils had recent experience of both systems it was possible to explore not just the actual transition, but also the differences the pupils perceived between the systems. This data needs to be treated with some caution as these pupils underwent a number of concurrent changes in addition to moving into sets: becoming year 6 pupils and hence the oldest in the school, a SATs dominated year and the imposition of a revision curriculum, preparation for transfer to secondary school and new teachers. The pupils showed an awareness of these simultaneous changes, understanding that change went beyond being put into groups:

> Rachel: Okay, now you said maths was different in year 6 because you are put into groups but weren't in year 5. What else is different about maths in year 6?
>
> Abbie: Erm, we just do revision really, we don't really learn many more, much more stuff, because we've basically learned all the basics, that's all we need to know to do maths.
>
> Ben: It's just revision.
>
> Rachel: Revision for?
>
> Abbie: SATs
>
> Ben: And secondary school exams
>
> (Parkview, Y6, S1, 21.01.08, Lines 217-225)

Pupils in Year 6 at Parkview, despite only being set in Year 6, appeared to settle into set ways of thinking and working very quickly. They demonstrated an understanding of the changes early on when I interviewed them within the first term of the change to setting:

> "Some of us are similar, but other children from the other class, we are kind of similar because in the other class there are people that used to be in our class the year before."
>
> (Catherine, Parkview, Y6, S1, 14.11.07, Lines 112-114)

Although Catherine does not explain it fully, she was talking about how the classes had been, as she saw it, mixed up (set) for mathematics. She had talked earlier about always being with the same children in her class, hence where her description of 'children from the other class' came from. While Catherine understood that there had been a split, Emily, in her individual interview conducted around the same time, went further to discuss the difference between the groups as there being separate groups for those who were good and not good at maths:

> "Because she is at the top, in Miss Barton's group, she is probably really really good at maths."
>
> (Emily, Parkview, Y6, S2, 14.11.07, Lines 71-72)

Within a term, these vaguer descriptions and understandings were tightened to bring in the typical level descriptors applied to sets and seen particularly at Avenue where setting was more widespread:

> Abbie: You have to be at least a 3 to be in this group.
>
> Ben: This group – well actually, no, I think it would be top of three, like 3A
>
> Catherine: 3A to 5
>
> Ben: Mrs Clifton's group would be
>
> Catherine: 3A to 5B
>
> Abbie: No, that's the same, probably around the 3s. Well maybe for our group it is 4s, like 4 – 5, and the other group is 3 and a tiny bit of 4.
>
> (Parkview, Y6, S1, 21.01.08, Lines 155-162)

Here, the pupils clearly understood the different sets and began to apply the language of levels to justify what the sets meant and who went in each set. There is still some evidence of ambiguity and challenge of practices – this is seen within Catherine and Abbie's exchange – but overall the pupils appear to be taking on an understanding of sets as levels, using a discourse of levels freely.

In addition to demonstrating an awareness and acceptance of levels and bringing this into their discussion of setting, the Year 6 Parkview pupils also began to rehearse the common understandings of the benefits and justifications of setting:

> Abbie: If like someone's really clever and someone doesn't really know much then the other person might not really know what they are talking about and needs to kind of learn a bit with other people who don't know.
>
> (Parkview, Y6, S1, 21.01.08, Lines 14-16)

Here Abbie talked about the need to separate those who were 'really clever' from those who 'don't know', but discussed this in such a way as to use setting to respond to everyone's learning needs. This is very much reflective of the justifications given by teachers and may also reflect family discussions. The pupils also talked about the different teaching in each set. Their understanding reflects both the literature and what was observed at both schools:

> Abbie: Same work but a bit easier, easier questions
>
> Ben: Yeah, maybe a one method question instead of a two method question
>
> Abbie: And easier numbers instead of thousands maybe using hundreds. Like if we have to times a number in the thousands by a number in the thousands, they might do a number in the hundreds by a number in the tens. The same thing but with smaller numbers so that they might understand it more with easier stuff.
>
> (Parkview, Y6, S1, 21.01.08, Lines 131-136)

However, this was still discussed in terms of being supportive to all pupils by ensuring that those in Set 2 who received 'easier questions' would be able to access the lessons. This comes despite one of the pupils raising the issue of differential access early in the same group-interview:

> Ben: It [being set] affects you in lots of ways, because you learn different methods and ways of working out.
>
> (Parkview, Y6, S1, 21.01.08, Lines 14-16)

Here, the pupils had been talking about what it meant to be put into sets and how it might affect you if you were put in Set 2. Ben talked about his friend who was in Set 2 and appeared to be drawing on this in his understanding that the sets were treated differently and had different access to the mathematics. One issue coming up repeatedly in the discussion of change was that of the reduction of collaborative work for pupils in both sets:

> Catherine: Well I think if you work with advanced people in your groups and people who are less advanced, maybe you can help them and the advanced people can try and help you and just basically work on what you know and try and improve.
>
> (Parkview, Y6, S1, 21.01.08, Lines 35-37)

> Abbie: And if you weren't put into groups then you could help other people if they don't understand and they could ask you questions about it and stuff like that.
>
> (Parkview, Y6, S1, 21.01.08, Lines 40-42)

These pupils raise the same problem with setting – an issue coming up across other Year 6 interviews at Parkview – that by being put in sets and apparently reducing the attainment range, they also lost the opportunity to discuss their work with other learners. It may be the case that it is not the reduction in the attainment range but a change in teaching methods brought about through setting that reduces this collaboration, but for the pupils, the effect is the same. Pupils in both sets talked negatively about this change, comparing it to the greater degrees of talk they perceived to happen in previous years when they were not set. This appears to fit with the data discussed previously where setting reduces talk at all levels. It suggests that the process of setting leads to a reduction in talk in all set classrooms.

In addition to eliciting pupils' perspectives on the differences between being in mixed-ability classes and being set, it was also possible to elicit teachers' beliefs about the differences, as through teaching different year-groups some had taught both mixed-ability classes up to Year 5 and set classes in year 6. The literature, particularly Hallam and Ireson's (2005) study, suggests that the same teachers respond differently when teaching different groups and sets. The teachers talked in their interviews particularly about how setting reduced the range and hence made their work easier:

> "I'm trying to remember if I preferred teaching maths this year or last year, when I had a class, and I think I prefer it this year because of the sheer range that I had last year."
>
> (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 347-349)

> "Yeah, goodness, it's a hard one that it seems a long time ago, which it probably was now. Did I find it easier? I might have found it easier, as I say, coming back to that planning being you know it was very much this is what we need to achieve level 5s, this is what is should be, you know you have your targets set, this is where they need to be and you focus very much on that, do I enjoy it? I think I enjoy it more where we are to be honest."
>
> (Mr Donaldson, Parkview, Y4, 21.07.08, Lines 231-236)

Miss Barton (teaching a set in Year 6 having previously taught a mixed-ability Year 5 class) and Mr Donaldson (teaching a mixed-ability Year 4, having previously taught a set Year 6) both discuss the same issues and potentially how being in sets changes the focus with outcomes being more assessment driven and accountability being more prominent. It is interesting to note that both state they prefer what they are currently doing; this may reflect teacher difference or a preference for what is currently familiar to them, but is important as it suggests that teachers have different motivations to prefer different methods. Both teachers talked about reducing the range as making teaching easier, something also highlighted in the literature, and hence this needs to be considered in looking at possibilities for change.

8.3 Table-Groups (Within-Class Grouping)

Whilst setting or between-class grouping is increasing in primary mathematics, other ability-grouping practices are also common in primary schools. One particularly common practice is within-class ability-grouping, often taking the form of table-groups. This is particularly prevalent in primary schools where extraneous factors make between-class setting infeasible, for instance in one-form entry schools. Pupils may be sat in ability-groups for all lessons or they may be moved into different groups for different subjects. This section focuses on two types of within-class ability-grouping. Firstly it looks at the most common type where within-class grouping is used within mixed-ability classes as in Year 4 at Parkview. However, it also looks briefly at Year 6 at Parkview where within-class grouping was used in addition to setting, effectively double-grouping pupils. As highlighted in the literature review in Chapter 3, there are a number of reasons why it is important to consider within-class grouping. Not only does the literature suggest a high degree of misplacement, but also that the group pupils are placed in is likely to have a significant influence on their outcomes as a result of different approaches experienced by different groups (Macintyre & Ireson, 2002). By understanding the pedagogic differences between groups we can begin to explore why these happen, and how they may be challenged.

Whilst pupils have groups for other subjects, mathematics tables seem to be stronger and more rigid. When shown a plan of their classroom and asked about where they sat, pupils' first response was often whether I was referring to 'normal' tables or maths tables:

> Rachel: Have a look at this plan of your class.
>
> Ivy: Is it your maths table or where you sit usually?
>
> (Parkview, Y4, Class 2, 15.01.08, Lines 5-6)

Whilst it may be argued that the pupils were aware I was interested in their mathematics lessons and so may have elected to talk more about these, their discussion of other groups felt different, less strong, and was often made as passing comments. Where other groups were mentioned, the implications of the mathematics groups often came across as stronger, as in Abbie's quote below where she attaches meaning to the mathematics groups but not to the groups in other subjects:

> "Well we have topic tables and science tables. Oralia stays there, she is always there, she just stays there. Katie goes there again and Archie goes all the way down there, but it's just a mixture, it doesn't mean anything. But for maths we've always been in the same place we have a special place for maths. I don't think anyone moves."
>
> (Abbie, Parkview, Y6, S1, HA, 27.11.07, Lines 48-51)

At Parkview I was present during lessons other than mathematics in Year 4, and these observations would suggest a much greater reliance on grouping in mathematics.

Whilst between-class sets are usually named by numbers or set position (top-sets and bottom-sets), within-class groups take on a variety of labels. This was obvious at Parkview but is also discussed extensively in the literature and reflects my experiences as a teacher. Whilst teaching I came across groups named by vehicles – from Ferraris to mopeds – and shapes – from hexagons, through squares, to circles – and in each case it was clear how the names had been chosen and applied and the underlying meanings. Dixon (2004) discusses this phenomenon, suggesting how common place it is and the ease with which pupils take on the table labels and associated meanings.

Pupils' sense of identity and hence the identity they enact is strongly influenced by how they are placed, productions of ability and the labels resulting from this. As previous chapters and research (Hodgen & Marks, 2009) have shown, practices surrounding and perpetuated by ability productions allow something very complex to be seen simplistically with pupils seeing themselves in terms of their ability identifier. At Parkview, in Year 4, many pupils strongly identified with their group labels. Of note this association with group labels and the associated meanings appeared to be stronger in the Year 4 class where within-class grouping was rigid and consistently implemented. In the following data extract, George, who experienced more ad-hoc grouping, still referred strongly to table-groups and their differences in terms of achievement:

> "Well, so there are like best and worst tables, like that's the first one, then that one then that one, then that one. Mine's the best one. Mr Donaldson does it so all of the people that are at the same standard are together."
>
> (George, Parkview, Y4, HA, 22.11.07, Lines 50-52)

However, without explicit labels, the group ownership appears less strong than it was with some other pupils, and George talks about his group, rather than being the identifier of the group. With other pupils, particularly those experiencing rigid table-groups, talk was based on taking on the group identifier individually, with that being what the pupils were, rather than them being members of a group. This is illustrated in the following interview extracts where Jessica and Kelly were explaining the significance of the different table-groups with the aid of a model of the classroom. Both pupils were in Mrs Ellery's Year 4 class at Parkview experiencing rigid within-class grouping:

> "[Top-Table] means that you're clever and that you know a lot of maths and you get the hardest maths. There's blue, yellow, purple, orange and green but orange and green are kind of the same. I'm green that's top. Orange is kind of the same as green but they're not as confident as green, purple and yellow are the middle and blue gets the easiest work and Mrs Ellery normally works with them … There, on the green-table, that's the top-table. The one there is the bottom and then it goes there, there, there, there, blue, yellow, purple, orange and green. Blue is bottom for children who aren't so confident at maths and they need easier work than the other people, like she doesn't give them so high numbers, she does lower numbers, like we get thousands sometimes and they just get tens or something."
>
> (Jessica, Parkview, Y4, HA, 07.12.07, Lines 26-31, 64-69)

> "Well I can sit anywhere around this table but not on other tables, because Mrs Ellery puts us into different groups, like maths groups, and she moved me from here to here. This means that you're good at maths, this means you are half at maths, the blue-table means you don't have a clue. That's the blue one, I'll colour is blue, it's like when you're stuck in maths and don't know what to do. This one is yellow which is where you kind of get it. This one's purple, that means you might get it, this one is orange, that's where I sit at, and this one is the green one that actually really get it. It goes round like that."
>
> (Kelly, Parkview, Y4, MA, 07.12.07, Lines 59-66)

For Jessica and Kelly their table-group colour is strongly correlated with who they see themselves as. Pupils referred to themselves as "a green person" and in doing so identified themselves with the limited ability/mathematical identity of that group, reducing how they could act and who they could be. Such a system, which allows pupils to know who they are, equally tells them who they are not.

Whilst George seemed content to talk in terms of best and worst tables, in other classes where within-class groups were rigid but not explicitly labelled, pupils imposed their own labelling system. This was particularly the case in Year 6 at Parkview where both ability-grouping systems were used simultaneously. Within the group-interviews the pupils used a plan of the classroom to talk about how the groups were arranged. In the Year 6 Set 1 interview at Parkview, the pupils added numbers to their plan – as well as indicating which was top – in order to aid their discussion (Figure 9).

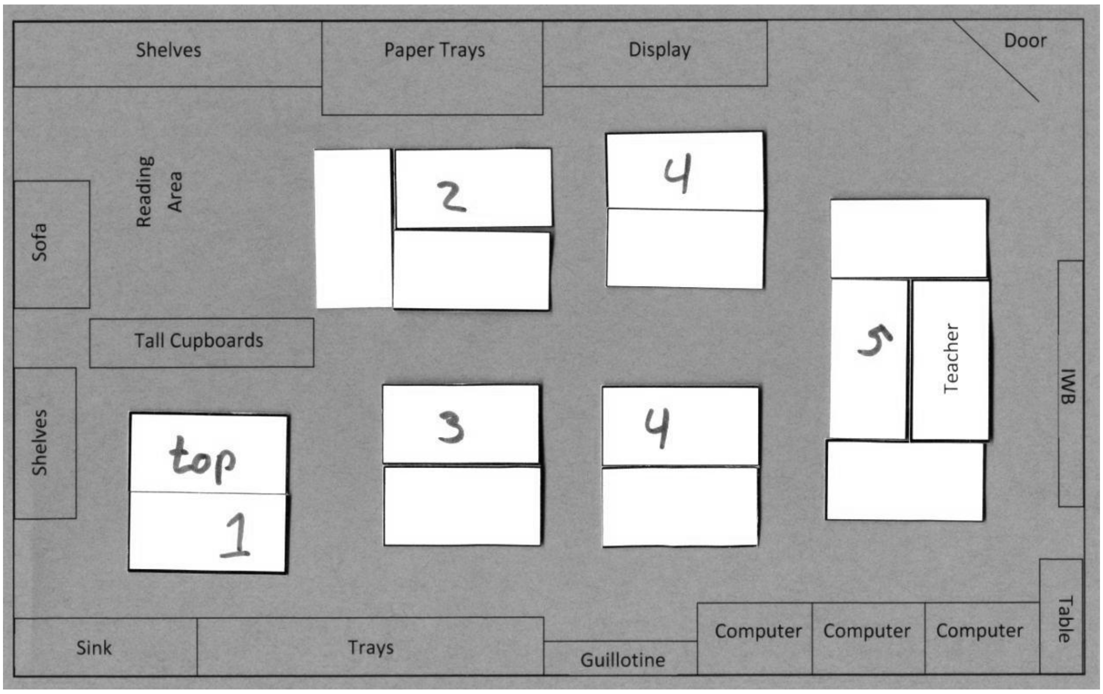


Figure 9: Classroom organisation – Parkview, Year 6, Set 1

Whilst these were not the group labels imposed by the teacher, the pupils seemed able to provide group identifiers and then associate these identifiers with the pupils in each group. This is particularly important because it suggests that these pupils have had previous experience of group identifiers and took such an action to be normal. Further, if pupils are accepting such grouping as natural, it may follow that they would accept the differential treatment of the groups. Further evidence of pupils' acceptance of group-identifiers came when Mrs Ellery's Year 4 class was taught briefly by a student teacher. During this time, the student teacher retained the use of groups but renamed these from colours to wild animals. Even though the animals selected were not explicitly related to group characteristics, the pupils quickly took ownership of these new names and labelled themselves as that animal rather than as a member of an animal group:

> Louise: And then the teacher changed it. And we said, oh, where are we sitting?
>
> Kelly: To animals. Because I'm a Bengal Tiger.
>
> Louise: I'm a Snow Leopard
>
> Jessica: And I'm a Panda.
>
> (Parkview, Y4, Class 1, 01.02.08, Lines 27-30)

When the student teacher left, Mrs Ellery reverted back to colours. However, these groups were arranged slightly differently to they had previously been. Despite this, the pupils quickly re-developed their understanding of the significance of each colour, and in their group-interview explained what each colour meant, writing this onto a plan of their classroom (see Figure 10).

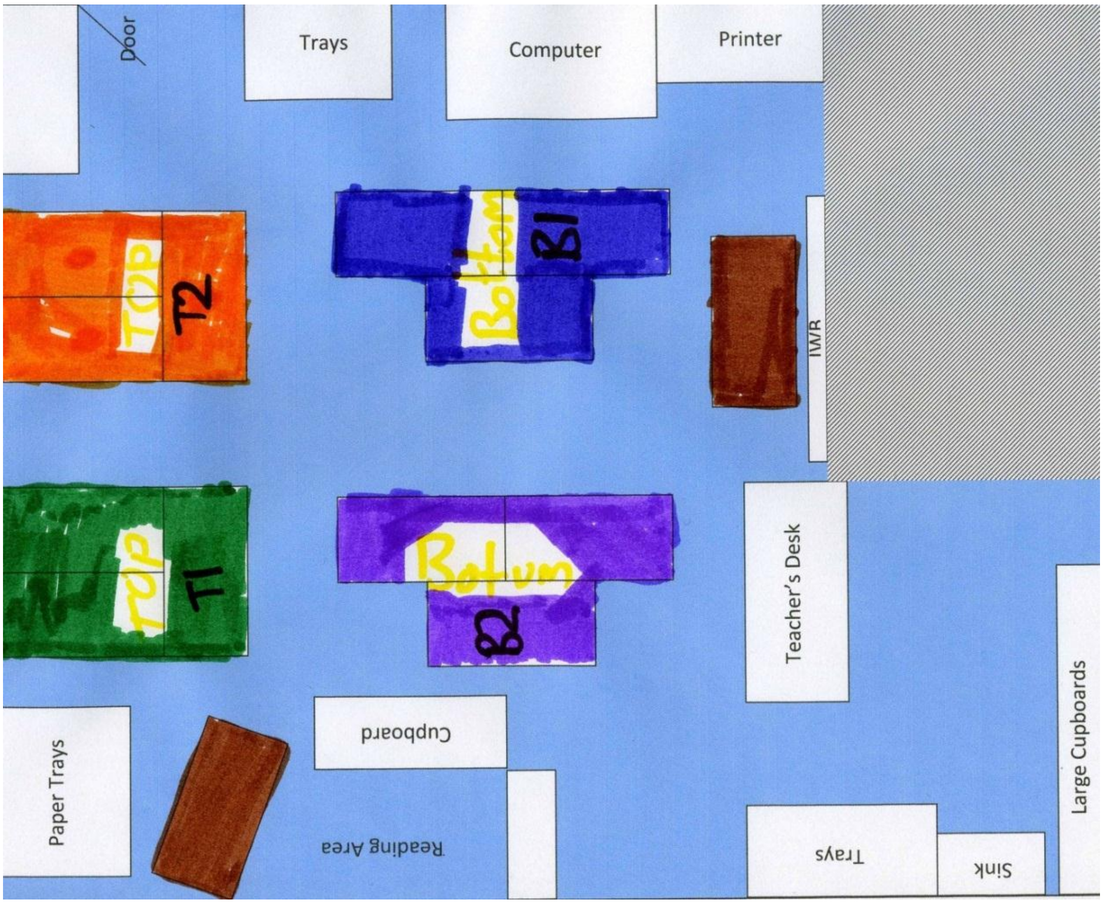


Figure 10: Classroom organisation – Parkview, Year 4, Mrs Ellery's class (B = Bottom, T = Top)

Using table-grouping, whether explicitly named or not, seemed to legitimise and strengthen pupils' beliefs about ability and individual differences. Even George, in Mr Donaldson's Year 4 class, who talked in his individual interview in terms of best and worst tables, brought concepts of ability into his group-interview discussion:

> George: Sometimes he puts the tables into ability-groups
>
> Helen: Yeah, because those people are all the same level
>
> George: Yes, they're the same ability
>
> Helen: That table and that table, the two back tables they are the same levels.

George: They're the same ability and…

Ivy: …and these front tables are kind of mixed, that one is really naughty and that one at the back talks too though

George: Huh, that's my table!

Helen: There are different levels though

George: Different abilities

(Parkview, Y4, Class 2, 15.01.08, Lines 61-70)

In this short extract, ability is mentioned four times, with the three pupils assuming a shared understanding of meaning. The tables are seen as physical markers of difference and explicitly labelled as "ability-groups". Although these pupils are still talking in terms of groups, the assumptions underlying this discussion appear strong. Levels are mentioned briefly, with these being conflated with abilities. By the time pupils reached Year 6, these labels appeared to become more specific. Pupils still used the concept of levels to demarcate groups, but these were now tied firmly with National Curriculum levels:

> "It's like 4A, 5A and stuff like that, it's your grades, meaning how good you are. At the end of the year they have SATs and they show you, last year I got 4A which is good and this year I'm hoping to get 5A, or a 5 level and I think she put me there because most of the people are level 4. She puts different levels on different tables, I think, I think she puts, I'm not sure, but these are 3As, level here, they're close to the teacher so that she can explain a bit more, and this is kind of the 4 and 5 middleish, these I would say 4, these are 4 ½ levels."
>
> (Ben, Parkview, Y6, S1, MA, 27.11.07, Lines 77-84)

Rachel: So how did Mrs Clifton decide where everyone sat?

Finn: Maybe for their levels because before I was sitting there and I was with that group, that's a separate group, there was a maths table, like the maths numbers, I think it was A B C and I was C I think, those tables were the A children and those were the B children but I was a C children. I was the only one sitting there. The Bs I think go there and that was C, no, erm, D. Was it D? A, no, no, yes, I mean it was A, not D, A, yes.

Rachel: What does being an A mean?

Finn: I don't know.

Rachel: Is there a difference between being an A and being a C?

Finn: B, they're right in the middle, the others are the top-table and the bottom-table. Top-table get the right answer, sometimes put their hands up, the Cs are not sure what we are doing or need help and don't understand it sometimes.

Rachel: So where do these letters come from?

Finn: The teacher gets them from our reports which she gets from Miss Attwood, the headteacher, or from our old teacher, they keep getting them from our old teachers, but if we do better, then Mrs Clifton will get like a new report and write a new one. Like in year 5, we needed to get a 3 or a 4 and in year 6 you need to get 4.

(Finn, Parkview, Y6, S2, LA, 26.11.07, Lines 61-78)

In both extracts, National Curriculum Level identifiers were combined strongly with the discussion of table-groups. In other interviews and general classroom discussion, pupils took on these identifiers in the same way the year 4 pupils labelled themselves as "a green person" or "a panda". A concern with this is that pupils are accepting an ascribed level and may then be more likely to fulfil that position rather than aim for change.

One of the major uses of table-groups, both in mixed-ability and setted situations, was to allow the differentiation of work. Pupils described this practice regularly, appearing to accept it as natural and legitimate, building on their understanding of ability-group differences:

> "Different tables get different work in the lesson, because they are at different standards, like different standards, because there is no point them, a worst table, doing a really hard one."
>
> (George, Parkview, Y4, HA, 22.11.07, Lines 56-58)

Louise: These two tables get easier work, and these two tables get harder work.

Kelly: Because like, when we do fractions and that lot, we do harder sums and they get easier or hard sums.

Louise: The harder ones, he makes up sums with big numbers

Kelly: Like thousands.

Louise: The easier ones have tens and twenties and add and take-away

(Parkview, Y4, Class 1, 01.02.08, Lines 37-42)

Although in academic terms the pupils appeared to take on an acceptance of table-groups and the provision of differentiated work, they also noted a number of difficulties with within-class-groups, all of which also relate to issues raised with between-class groups. Mr

Donaldson's class reflected on why he did not always put them into maths groups. One rationale they produced, confirmed as an accurate interpretation from classroom observations, was that movement into groups was time consuming:

> Helen: When we used to swap everyone used to make lots of noise and then they had to calm down again and we just wasted a couple of
>
> George: Minutes
>
> Helen: Yeah minutes of our maths lesson. We did swap last term, but not this term.
>
> Rachel: Why do you think you haven't swapped?
>
> Ivy: Because he's not bothered
>
> Helen: Maybe he forgets
>
> Ivy: He's a Silly Billy
>
> Helen: No. It's because people waste too much time.
>
> Ivy: Well there's no point anyway because instead of going somewhere we could stay in the same place and just get on.
>
> (Parkview, Y4, Class 2, 15.01.08, Lines 23-33)

With setting, there were also issues raised of the implications of the between-class movement. Although this tended to relate more to pupils losing pastoral contact time with their class-teachers (discussed in section 9.3), the movement involved in both systems suggests that the impacts go beyond the obvious. A further issue to arise, discussed earlier in this chapter in relation to setting, was the change in group dynamics. Louise and Kelly talked about this in their interview, where moving into table-groups meant the girls were no longer working with pupils they were comfortable with:

> Louise: You know in the groups? It takes you away from your friends, and sometimes it's like boys and one girl
>
> Kelly: Yeah there's three boys on that table
>
> Louise: And they get on your nerves, they keep kicking me. Keeps kicking people.
>
> (Parkview, Y4, Class 1, 01.02.08, Lines 138-141)

Although they do not suggest this directly, it is feasible to infer that if the girls are uncomfortable in their groups, they are not going to be working collaboratively, hence, as with setting, this is one way I which within-class ability-groups may reduce collaborative talk.

In the group-interviews, I asked the Parkview pupils about how they would like to arrange the classroom. This task proved to be very revealing in terms of pupils' perspectives. The models produced were mixed, but the discussion pupils had whilst constructing them often involved complex discussions of ability and behaviour. Reflecting the finding that bottom sets had a behavioural focus, pupils designing classrooms suggested that pupils who were badly behaved would form groups near the front of the classroom and pupils who were "clever" or "good at maths" would have tables towards the back of the classroom. Although discussion were still focussed on discourses of ability – perhaps pupils had no alternative discourse to draw on – their designs tended to be more flexible than the rigid groups they experienced in classes. This was particularly the case for Mrs Ellery's class who experienced the most rigid within-class grouping. They debated multiple models, settling on two: one involving grouping and one not. In their group based design they suggested the need to include the possibility for change so that individuals did not always stay in the same group and could improve:

> "When people get better at maths, they can move up"
>
> (Louise, Parkview, Y4, Class 1, LA, 01.02.08, Line 106)

Further, and reflecting some of the literature on potential positive practices (Askew & Wiliam, 1995), they suggested limiting the number of groups to two groups, and having these formed of near-ability pairs:

> Jessica: I think it should be like two groups instead of four and then we get to mix, and we get to all do the same but in two groups.
>
> Kelly: It would be these two together and these two together.
>
> Jessica: It would give everyone some help. So there would be the clever and like not clever, but not bottom, sort of middle, together. And then some like them and the bottom. It's in two groups.
>
> (Parkview, Y4, Class 1, 01.02.08, Lines 144-149)

Reflecting the concerns raised with all grouping methods that they reduce the possibility for collaborative, talk and mutual assistance, Jessica went on to suggest that the setup should allow for collaboration and for pupils to help and learn from each other. It is of particular note that this extract comes from one of the highest achievers in the class, suggesting that they may not, as some of the literature suggests, feel aggrieved at supporting their peers:

> "The clever people are spread out, so that the adults, the better maths, are spread out, so that these people, if they don't know how to do it, they've got clever people on both sides of them so they can hear both people and just ask them."
>
> (Jessica, Parkview, Y4, Class 1, HA, 01.02.08, Lines 73-76)

In a final discussion, the three girls suggested a very different model which moved away entirely from table-groups. This model resembled the horseshoe espoused in the early National Numeracy Strategy documentation although the pupils' direct experience of it came from their British Sign Language lessons taught as part of the inclusive school environment:

> Jessica: I would quite like a big circle, so we can all see each other, like in BSL, but it probably won't happen.
>
> Kelly: Because in BSL, we just sit like that, all around.
>
> Louise: Plus we have to sit girl, boy, girl, boy. I don't like that.
>
> Jessica: But if it was a circle, we would get to see each other, and it would be good because we would all be like where we want to sit and it wouldn't be as groups and people wouldn't think oh I'm better than everyone else or I'm worse than everyone else and be sad, and people think that now, because they are on the top-table or the bottom-table or something
>
> Louise: It makes you know you're worst at maths
>
> Jessica: And that makes her think she's not very good at maths. And other people call me the maths queen which I don't like because it seems like showing off and being the teacher's best pet.
>
> Louise: Yeah, because they think Jessica's really good at maths and knows all the answers because she sits there.
>
> Jessica: Well normally when I've finished, I go over to that table because Sara's a bit slow, so I go over there and help them. Sometimes if we've finished we don't get more work, so we help or read.
>
> (Parkview, Y4, Class 1, 01.02.08, Lines 118-135)

This discussion seems particularly important as it suggests that the pupils hold concerns about current practices and that they are thinking about alternatives. Importantly it also highlights that possibilities exist for change. It is important to understand the pupils' perspectives on ability-groups in order to address these specifically in proposing new models. In particular, this section suggests that within-class grouping can be just as stigmatising as setting with pupils readily taking on group identifiers. Further, many of the implications – such as loss of collaborative work – are similar, something which may not be expected when pupils are still within mixed-ability classes.

8.4 Secondary School Selection

The practices surrounding secondary school selection, particularly with over-subscribed and selective schools, are complex. These may be confusing for pupils, particularly where their parents attempt to negotiate the systems and secure advantages for their children. Pupils may be taught to 'play the game' with respect to particular practices to give them the best possible chance of admission. However, this may cause confusion if they are taught to engage in apparently contradictory practices.

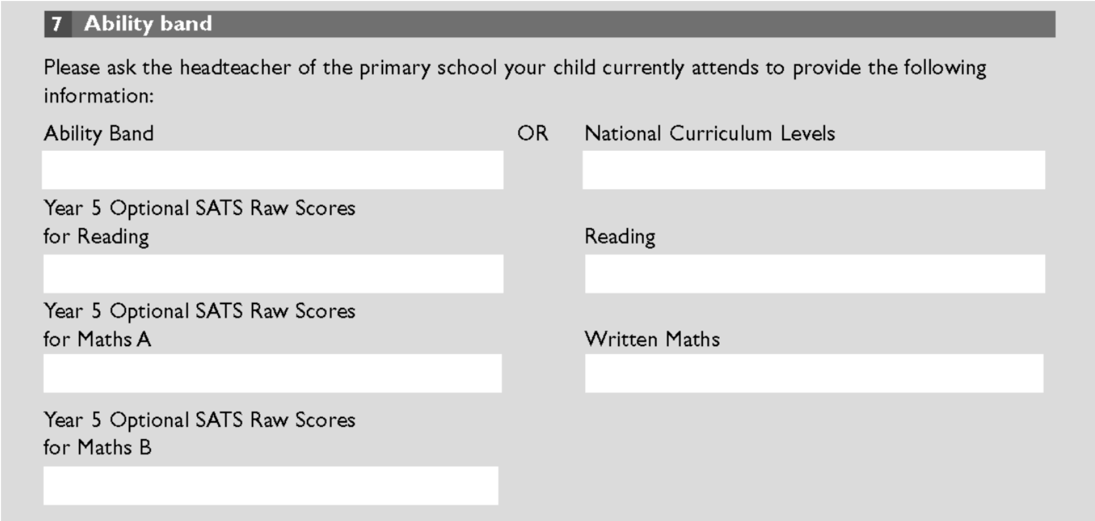
Parkview and Avenue were located within or near Local Authorities containing over-subscribed academically selective secondary schools with highly competitive entry. In addition, the primary schools fed to a range of other secondary schools including over-subscribed non-selective schools, church schools and private schools offering bursaries to low-income families as well as non-selective state secondary schools, some of which were unpopular with some local families. This range of options was confusing to pupils – and possibly parents – and added to myths about what secondary school would be like, with some myths intensifying beliefs about ability.

Preparation for secondary selection began early. Whilst transition is usually thought of as the time immediately around change, the processes of secondary selection led, for some pupils, to a protracted transitions period. In their now dated study, Measor and Woods (1984) examined the process of changing to secondary education on final year primary school pupils. They found this final year to be peppered with "indicators of transition", signalling to pupils that change was about to occur. A number of the indicators identified – teachers' references, last term, official documentation, visits – were the same then as they are now. However, in an era of purported parental choice, the stakes appear far higher, and as a result, these transition indicators appear earlier in primary pupils' careers. I had expected Year 6 pupils to be aware of aspects of the upcoming change and for this to be brought into their beliefs about ability; I was surprised by the extent to which many Year 4 pupils also had strongly developed understandings of secondary selection and related ability predicated practices. At Avenue, for example, Year 4 pupils, particularly those in the top-set, spoke with a well-developed understanding of secondary selection:

> "I think it's because some grammar schools have got quite a high reputation so everyone who is like really really clever goes there, and like, so they want to test, they test you to see if you are clever enough to actually go to that school, to keep up their reputation."
>
> (Thomas, Avenue, Y4, Set 1, 07.02.08, Lines 101-104)

Thomas was not yet half-way through Key Stage Two at the time of this interview, but he was already transfixed by selective schools and selection criteria. There appeared to be a pressure on him to work towards a grammar school place and the discourse around grammar schools fed into his beliefs about ability; having a school catering for those who were "really really clever" legitimised ideas of innate difference.

Across both schools and year-groups, pupils reproduced much of the language surrounding secondary selection: sibling policies, verbal and non-verbal reasoning, catchment areas and banding. Banding was a particularly strong discourse for pupils in Year 6 at Parkview. Banding is used within the school's local authority within their admissions criteria as 'a fair way of making sure every school has a good mix of students from all ability levels.' With banding, local authorities are free to stipulate how many bands they impose and the proportions of pupils allocated to each band, although schools are required to have an intake reflective of the proportions of pupils in each band nationally, locally, or applying to a particular school. It is unremarkable that banding exerts a powerful influence on pupils; they are all tested and allocated to a band in Year 5 and the school admissions form focuses heavily on banding and / or National Curriculum levels (Figure 11).



7 Ability band

Please ask the headteacher of the primary school your child currently attends to provide the following information:

Ability Band OR National Curriculum Levels

Year 5 Optional SATS Raw Scores for Reading

Reading

Year 5 Optional SATS Raw Scores for Maths A

Written Maths

Year 5 Optional SATS Raw Scores for Maths B

Figure 11: Secondary school application form – ability banding request

As a result, pupils brought banding into their discussions of secondary selection, with it legitimising conceptions of ability. Abbie, for instance, demonstrated a thorough understanding of what is a fairly complex process:

> Abbie: SATs are more like year 6 exams, and in year 5 they're like banding exams, that bands you like, some people are 1A and 1B and to get to, well some state schools, they get a certain amount from 1A, a certain amount from 2A, some from 1B, and the others.
>
> (Parkview, Y6, Set 1, 21.01.08, Lines 233-236)

She demonstrates an understanding of the bands applied, how they relate to admissions, and takes on the underlying notion that each individual pupil belongs in a particular band. However, although Abbie shows a deep understanding of the process, other pupils had picked up on aspects of the process but developed incomplete understandings:

> Delyth: Yeah, you know in secondary school, when you go to secondary school you get a band, you know, do you know?
>
> Rachel: Tell me a bit
>
> Delyth: Well you do kind of like loads of tests and you get kind of like a banding and 1A is the highest and 1B is the second and it goes to 1C does it?
>
> Emily: Yeah.
>
> Delyth: And then there's 3, I mean 2A, 2B, 2C and then there's just 3 isn't there?
>
> Finn: 4, 5.

Emily: I think it goes up to 5.

Delyth: Does it?

Finn: On Oralia's thing, it goes up to, on Oralia's work it said 6A and 6B on the computer it says all of our grades.

Delyth: Oh. Well I don't know where it goes up to, but I got like … no, she couldn't have got that because 1A and 1B are the highest. I know what Oralia got, she got a 1A, because that's the highest, and I got a 1B. What did you get?

Emily: I don't know I can't remember.

Delyth: Well I remember I got a 1B.

Rachel: A 1B?

Delyth: Yeah it means…

Emily: It's not just about maths

Delyth: No, it means you understand most of the subjects like well and stuff.

Rachel: And the secondary schools use them?

Delyth: Yeah, they put all the children that apply for their schools in the bands, in what bands they got, and then they take a few out of each band, I think that's what happens, just so that they have a variety of different children, I guess.

(Parkview, Y6, Set 2, 12.02.08, Lines 186-210)

This discussion shows some understanding, but suggests confusion which appears to arise particularly where banding outcomes have been conflated with other assessment outcomes, most likely National Curriculum levels. Delyth appears to have an understanding approaching Abbie's understanding, but Emily and Finn seem less sure. Given the confusion surrounding some aspects of selection as well as the intensity of transition and selection discourses in pupils' lives, it is unsurprising that pupils display an awareness of the pressure on them and increased anxiety, talking about schools that are "hard to get in" and contemplating their chances of successful applications. Pupils' sense of the importance of securing selective secondary education in both Years 4 and 6 was intensified by their parents buying into shadow education in the form of tutoring or Saturday schools to potentially give their children an advantage. It became clear across the interviews that it was the highest achieving pupils who were receiving this form of shadow education and the pupils understood its purpose:

"I'm there [tutoring] to get into a good school."

(Victoria, Avenue, Y4, Set 1, 06.05.08, Lines 38-39)

Uma: So that's why if you want to get into a good school, I'm having tutoring at the moment to get into Maples Girls' and Mr Iverson thinks that I'll probably get into a really good school like that.

Victoria: My friend has tutoring and she's really clever.

Uma: My tutoring is like an extra hour of school. It's basically like going to school, except you go to someone's house and you study things

Thomas: Or they come round to your house

Uma: They main thing they want you to do, the tutor I've got home-schools her children until when they go into things like Maples Girls' and then they will probably get them to take an exam so that they get into a school, she will probably try to put them into a school even if they're not in a school at the moment, so she's quite clever because she home-schools her own children. I go on a Monday for an hour and a half and we study maths and English because that's the main things that they want you to do in the tests.

(Avenue, Y4, Set 1, 07.02.08, Lines 110-123)

Abbie: The school doesn't get you ready for the secondary school tests, if you want to get really good at that you have to do it at home in your own time.

(Parkview, Y6, Set 1, 21.01.08, Lines 239-241)

In each example, the pupils express an understanding that tutoring is provided because they are already labelled as high-ability, not as a result of low-attainment. They see the sole purpose of engaging with tutoring as being to pass the tests and gain admission to a selective school. The split between pupils receiving tutoring and those not, along set lines, was particularly revealing. Set 4 pupils at Avenue were aware of tutoring and its purpose, but did not receive it themselves:

Wynne: On Saturday I go to singing, dancing and drama so I have a little extra school on Saturday, so I get better but some people do extra maths like extra school on the weekend

Zackary: Yeah, it's called Saturday school

Wynne: And some people have tutoring

(Avenue, Y4, Set 4, 30.04.08, Lines 49-53)

Whilst Wynne is engaged in extra-curricular activities on a Saturday, these pupils were not involved in extra academic activities with the purpose of supporting an application for selective secondary education. Whether there were further reasons behind this, such as parental or teacher beliefs, is unclear, but it does suggest another way in which ability works to widen the attainment gap between learners: those who are already in top sets are receiving further academic input, whist those in bottom sets are not.

Whilst this additional tutoring is set up to be supportive to pupils, secondary selection generally, and tutoring effects specifically, were found to be of source of increased anxiety for pupils:

> "Sometimes maths lessons can be really really not nice when we do like tests and stuff, because sometimes it makes you worry a bit about the tests that are going onto your secondary school and stuff like that so you worry about that and the way that you are learning it and sometimes if it's for the test that goes to your secondary school and you don't get the method to help you do that test, you can get like really worried and some people aren't brave enough to put their hand up to the teacher which makes it worse because then they are not actually going to get it, but, well the tests for secondary school might be a really really bad test because I might have not been listening and I might not have catched the method as easily as I thought I would have catched it which makes it harder for me to do those sums in the test and the working out and stuff."
>
> (Emily, Parkview, Y6, S2, MA, 14.11.07, Lines 136-146)

Worries around the selective tests and secondary placement spread into Emily's mathematics lessons. Linking what was taught with what was needed in the tests, she expressed a concern about missing any aspect of the mathematics curriculum and then not having the necessary knowledge or skills to apply within the test. She talks about how increased anxiety impacts on her own and others' classroom behaviours with them not being "brave enough to put their hand up". This suggests that the impact of the selection tests goes beyond the test and the time of the test itself, potentially having a wider impact on pupils' beliefs and attitudes within mathematics lessons.

Measor and Woods (1984) discuss the myths pupils build up surrounding secondary school. Whilst these tend to focus on social elements, they also found academic myths surrounding specific subjects such as dissection in science. Within the context of mathematics, pupils at Parkview also built up myths about what mathematics would be like at secondary school and what they would be expected to know in order to secure a competitive place. For unclear reasons, possibly linked to topics covered within tutoring, one key myth centred on needing to know and be able to do algebra, with this coming up several times during the group-interview:

> Ben: They have something called multiple choice. There's verbal reasoning, there's English and there's maths and you have to pass all of them.
>
> Abbie: My sister said the maths was really long but when I did it I found the maths wasn't very long, but the main thing they look at is your English if you are borderline of getting in or not, like on the edge of getting in.
>
> Rachel: And is the maths like maths you do here?
>
> Ben: No! There are algebra questions
>
> Abbie: And the x and y thingy, you know, if someone in 5 years' time is x years old, how old will they be now, like you have to work out x.
>
> Ben: It's like the secondary school, because you kind of do algebra in the secondary school so they are seeing if you know a bit now, otherwise if you don't know it you will find it difficult.
>
> Catherine: Yeah, it makes the school better because they want people who know it already.
>
> …
>
> Abbie: Algebra, we don't do that here, we just have to learn it ourselves, but in secondary school you do do it.
>
> Rachel: How do you learn it yourself?
>
> Abbie: Well…
>
> Ben: At home, you buy books from WHSmiths! (laughs)
>
> Abbie: Well I had a tutor that came in to do it with me because I wanted to go to the good secondary school and taught me algebra and stuff and things that I probably wouldn't learn at primary school.
>
> (Parkview, Y6, Set 1, 21.01.08, Lines 265-277, 289-296)

These pupils began by talking about what the selective tests would be like and what they included. However, their key focus, both of what was needed for the tests and of how mathematics would be different at secondary level, was on algebra. Algebra takes on a particular significance for these pupils, acting almost as a gatekeeper to selective education as well as being an indicator of ability. These pupils had already identified selective schools as where those believed to be high-ability go, and they were now adding to this, suggesting the necessity to possess specific curriculum knowledge not taught within the primary school. Algebra then also acts as an indicator of awareness of entry requirements and of accessing shadow education. If these pupils are accurate in their understanding of what is required, only those high-achieving pupils accessing further academic teaching or receiving extensive support at home have the possibility of success in the selective tests. Again, notions of ability serve to widen the gap between achievers through dictating not only who has access to higher knowledge, but also who has access to understanding of that higher knowledge.

For pupils at both schools, and I would argue more generally as selection practices are similar across Local Authorities, secondary school admissions and associated tests – both banding and academic selection tests – act as explicit practices of an ability discourse. In a circular argument, these practices legitimise beliefs of individual fixed differences through being put forward as fair ways to allocate pupils to schools whether in selecting the most able or ensuring a mix of abilities. Additionally, the practices themselves are legitimised through our ideology of ability and beliefs in fixed ability levels. This suggests, as with other issues discussed in this chapter, that change will be very difficult, because systemic change would be required in order to break these cycles of perpetuated beliefs.

8.5 Chapter Conclusion

In this chapter I have looked at the most visible and commonly cited practices of ability. These are the practices which form the basis of most research into ability-grouping, although, as highlighted previously, much of this research is secondary based and tends to focus on one outcome measure. I have attempted to address these issues, looking at how the pupils at Avenue and Parkview experienced the most explicit practices of ability, and the impacts of these on both teaching and learning and on identity formation. Within this analysis I have showed these explicit practices to have multiple productive and reproductive features, sustaining a discourse of ability within and beyond primary mathematics. I have also shown that many of the outcomes of explicit ability practices – particularly *all* forms of ability grouping – are the same for all pupils. These include limited space for understanding and a lack of discussion and collaborative work between pupils.

The reasons for these outcomes are different across sets and grouping practices, but all are instigated or strengthen through ability beliefs and associated practices.

The common, explicit, practices discussed in this chapter are only part of pupils' experiences. Ability still has impacts in the absence of explicit grouping, and grouping brings additional consequential implications. In the following chapter I examine these more implicit and less well documented outcomes and investigate how they work, with the practices identified in this chapter, to produce and reproduce understandings of ability.

9 Consequential Practices: What else happens when we differentiate by ability?

9.1 Introduction

Chapter 8 examined the impacts of common ability-predicated practices. These are practices, such as setting, which are explicitly linked to a stratifying discourse of ability and where the direct impacts of being part of such practices are considered. The majority of the literature on ability in mathematics education (at both secondary and primary level) focuses on these direct impacts, often in terms of attainment and attitude. However, these explicit practices may bring with them unintended practices and consequences. This chapter examines some of these unintended practices and consequences, examining their prevalence and their impacts, particularly in terms of the production and reproduction of discourses of ability.

9.2 Ability Based Interactions in Mixed-Ability Classes

The research design gave access to a variety of ability practices. This allowed me to explore the impacts of ability outside of common practices such as setting. Whilst Parkview, as discussed in Chapter 5, used more ability-grouping than initially believed, it still provided an environment in which to explore the impacts of ability in unsetted classes. In Chapter 8 I looked at within-class grouping as a common strategy in primary schools; in this section I investigate where and how ability may have an impact outside of explicit grouping in Year 4 classes at Parkview.

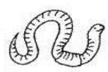
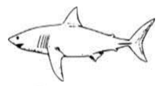
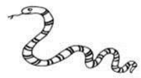
The following extract is from an observation of Mrs Ellery's Year 4 class at Parkview. This class were rigidly table-grouped, but in this lesson the whole-class were working on the same problem-solving task. This discussion focuses on observed interactions that may be predicated by ability but which fall outside of differential group teaching.

> The pupils are working on a problem-solving task focussing on multiplication. All pupils are doing the same task, working in pairs. Pupils have to choose 12 animals in any number of groups (i.e. 4 cats, 5 spiders, 2 ducks and 1 elephant) and work out how many wellington boots the animals would need in total. The teacher goes through the task on the Interactive White Board showing the pupils how to work it

out and complete the given table before doing it themselves with their choice of animals.

A pair of pupils on the blue (lowest) table talk animatedly about the animals they are choosing, laughing that they are going to pick underwater animals without any legs so their answer will be zero. They choose 5 goldfish, 5 whales and 2 sharks. They write out the maths as they have been asked, to show that their animals require no wellingtons and get up excitedly to show what they have done to the teacher. The teacher looks very briefly at their work, tells them the table is untidy and their handwriting difficult to read before telling them off loudly in front of the class for not picking sensible animals and not doing the task properly. They are given a clean sheet and told to repeat the task correctly. The pupils return to their table but do no further work.

Towards the end of the lesson, the teacher asks some pupils to share their work with the class. A pair from the green (top) table goes to the front and shows their work to the class. Before looking at the maths they have done, the teacher praises them for completing the work so neatly saying that this makes the maths they have done easy to understand. The teacher then asks one of the pair to read out what they have written to the class whilst the other pupil completes the table on the Interactive White Board. The pupils read, draw, and write out:

Animal		**Number**	**Legs**	**Boots**
Worms		4	0	0
Sharks		6	0	0
Snakes		2	0	0
			Total:	**0 boots**

The teacher laughs along with the pair and the rest of the class, telling them they are very clever choosing animals with no legs. She praises the pupils for their good thinking.

(Parkview, Y4, Class 2, 07.12.07)

This account illustrates how teachers may respond differently to similar situations. This is an illuminating extract because these situations occur within the same lesson, with the same teacher, and within approximately 20 minutes of each other and it could reasonably be expected that when the teacher encountered the second situation she would still have some memory of the first. The first pair of pupils encountered a negative reference to non-mathematical aspects of their work and two behavioural reprimands audible to the class. The second pair of pupils encountered positive teacher engagement, reference to their neat work with some, albeit minimal, linkage made between this and a mathematical context, and praise encompassing words including 'clever' and 'good' which the rest of the class were encouraged to be a part of through sharing in the teacher instigated laughter.

It is not possible to say that the differences in the reaction of the teacher are entirely due to mathematical-ability labels, yet this is potentially a relevant factor. Whatever the rational for the different treatment, pupils pick up on these differences and incorporate them into their understanding of ability. Hence, even if the teacher's actions are unrelated to perceived ability differences, the actions may become about such differences.

The first pair of pupils – expected to perform a low-ability identity – break out of these expectations, performing aspects of a high-ability identity: working quickly, getting their work correct (the mathematics they completed was correct for the numbers chosen) and working with enthusiasm. These behaviours are reconstructed by the teacher, realigning the pupils with their low-ability identity. Rather than acknowledge that they have worked quickly, their work is referred to as difficult to read. This comment, highlighting common value-judgements about neatness in primary classrooms, ties in with, and strengthens, pupils' productions of ability. Through disapproving of the pupils' approach to the task, the teacher draws the attention of other pupils to what have been reworked as poor classroom behaviours. Further, the pair of pupils moved from a state of visible engagement to one of disengagement and dejection. In effect, they began to perform the 'correct' behaviours for their ability label, potentially strengthening their own, and other pupils', understanding of their mathematical identity.

The second pair of pupils produced limited work in comparison to other pupils given the numbers chosen and the limited mathematics involved. They produced the same quantity of work in the lesson that the low-ability labelled pair had completed 20 minutes earlier. However, the teacher makes no reference to this, instead focussing on positive aspects of the work, linking these to being mathematical and potentially strengthening a mathematical as opposed to behavioural identity for these pupils. It is possible that the teacher's production of them as 'able', feeds into her production of them as working mathematically. Whilst the teacher did not identify the first pair's work on multiplication by zero as mathematical, having time to think this through, and then having it re-presented to her by an 'able' pair, may have allowed her to reconstruct multiplication by zero as important and mathematical, rather than time-wasting and inappropriate. The teacher's use of ability-based language – "clever" and "good thinking" – may produce and reproduce pupils' understandings of mathematical-ability. This language is part of pupils' productions (see Chapter 7) and interactions like this suggest how language may be reproduced by the teacher.

Having looked at possible ability-predicated interactions in Mrs Ellery's lesson, I now examine the same lesson content (the teachers planned together) in Mr Donaldson's Year 4 class, where ability-groupings were not explicit. Mr Donaldson began the task by setting the scene and providing a context. He explained that the Prime Minister had passed a new law requiring all animals to wear wellington boots. This was illustrated with images on the interactive white board. He explained that his friend was worried because she had a large number of pets: 3 cats, 5 starfish, 3 budgies, 2 goldfish and 6 spiders. Taking each animal individually, he asked the pupils to use their whiteboards to work out how many wellingtons would be needed. Mr Donaldson took answers from different pupils, writing these on the board.

Whilst Mr Donaldson's discussion appeared to involve all pupils equally, differences, possibly predicated by ability, became apparent when the discussion was focussed on written mathematics. The pupils were not told to use any particular method. When asked to work out how many wellingtons the spiders would require, two pupils, Sian, labelled low-ability and Raymond, labelled high-ability, produced different responses on their whiteboards (Figure 12).

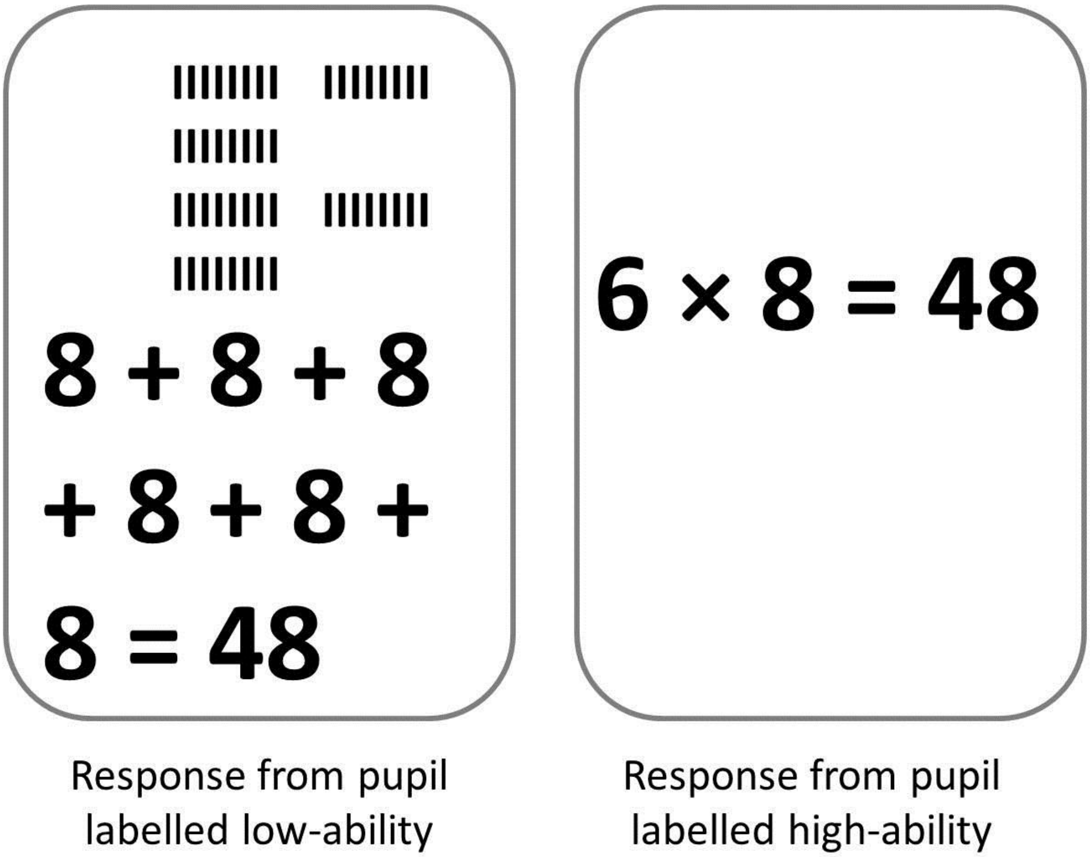


Figure 12: Whiteboard work – high and low-ability labelled pupils

When asked for their answers, Sian put up her hand and showed her board, whilst Raymond did not raise his hand. Despite Sian making it clear that she wanted to answer, Mr Donaldson stated to the class “Ah, I see Raymond has the correct, neat answer” and directed him to show his work. It may be that Mr Donaldson wanted to focus on multiplication as the learning objective of the lesson, but this brief dismissal of Sian and interaction with Raymond may have been ability predicated and had the potential to strengthen ability productions. Sian was very vocal in wanting to share her work, yet Mr Donaldson’s emphasis on Raymond as being correct – particularly in light of the two boards looking so different – may have led other pupils to believe that Sian was incorrect. Additionally, the focus on Raymond’s answer as ‘neat’ adds to the production of one pupil as able and another as not.

Following the whole-class introduction, Mr Donaldson asked the pupils to complete the task individually. Mr Donaldson worked individually with various pupils. Whilst pupils were sat in mixed-ability groups, there appeared to be differences in the quality of these interactions. Whilst much of the interaction comprised of normal classroom discourse – explanations, behavioural reprimands, etc. – Mr Donaldson's interactions with George, my high-ability labelled focal-pupil, appeared qualitatively different. George had, in his words, "made the work interesting" by including animals such as a 306 legged-millipede. Rather than being reprimanded as may have been the case with other pupils, Mr Donaldson positively encouraged this, with a degree of banter evolving between him and George and the provision of improvised extension work involving the cost and sizes of the wellingtons. This interaction had two possible ability impacts: it highlighted high-ability behaviours and it gave a high-attaining pupil access to extended mathematics, potentially increasing the attainment gap. This lesson was not the only one where Mr Donaldson's differential actions impacted in these ways. In other lessons, discussed further in Chapter 10, co-constructive identity work took place between the teacher and pupils, building up understandings of ability and allowing for differential curriculum access.

Not all ability-based interactions were teacher led. In another lesson, the pupils were practicing telling the time using analogue clocks:

> Mr Donaldson has the pupils working in pairs. George (HA) is working with Oliver who is labelled low-ability. Each pupil has a small geared analogue clock. They take it in turns to make a time for their partner to identify and award a point if they get the time correct. Initially, George appears to be helpful to Oliver, selecting simple times – on the hour or half past – and helping Oliver attain the correct answer and obtain a point. George maintains this for a while, with the boys' scores being equal. Then, Mr Donaldson tells them that they have two minutes left. George whispers to me "I'll do him a really hard one, even though he's not going to get it." On his next two turns, George chooses 5 past 12, telling me "he'll think it's 1 o'clock" and then 7 minutes to 6 which may have been selected to look like half past 10. On the basis of these, George moves two points into the lead as Mr Donaldson asks them to stop. He then asks them to put their hands up if they won, and George raises his hand high.
>
> (Parkview, Y4, Class 1, 22.11.07)

Here, George appears to apply ability judgements to manipulate the outcome of the task to his advantage. He appeared to be aware, as was common practice for Mr Donaldson, that they would be asked who had obtained the most points and that this could be used to strengthen his position in the class. A simple practice of awarding points moves the focus away from the mathematics and makes this a competitive exercise. It relies on an assumption of difference between pupils and that some will obtain more points than others. This alters pupils' access to the mathematics and to supportive collaborative relationships, as pupils are forced into a position of competing against each other. Initially, George appeared to be supportive of Oliver, but this changed when his ability-identity was potentially at stake.

The lesson extracts discussed in this section show how ability can still impact on practices – of teachers and pupils – outside of explicit grouping. Ability appears to be a strong enough discourse that teachers and pupils are driven to stratify thoughts and practices, although these may seem so natural that the stratified actions are not explicitly noticed.

9.3 "It's not just maths": The disciplinary focus of setted lessons

The thematic coding of "it's not just maths" is grounded in the pupils' data. It relates to the shift in teachers' foci – from the traditional pastoral focus of primary schools towards a solely mathematics focus – as a consequential and often unacknowledged impact of setting. The implications of this shift are far-reaching as pupils' wider learner and social identities are ostensibly ignored. In this section, I examine these impacts.

Where rigid setting is used, particularly with multiple sets and non-year group teachers, many teachers only see the pupils in their set within the context of the mathematics lesson. This may result in the teacher seeing their role as only being about teaching mathematics, far removed from the traditional role of a primary teacher. Set pupils – at all levels – spoke eloquently about the intense mathematical focus they were subjected to and the requirement only to focus on the mathematics. However, school, particularly at the primary level, is not just about the individual disciplines. Pupils suggested the mathematical focus of sets felt false and negated their membership of other groups, for instance their usual class and friendship groups. The separation of mathematics from pupils' wider social contexts has, as Bibby (2007, p. 2) states, also been an issue with some earlier studies which 'consider mathematics learning in isolation, excised from related learning contexts; partially, perhaps, an inevitable consequence of considering the subject in contexts where the mathematics is structurally separated from other aspects of learning by school … organisation.' If we want to look at pupils' participation, we need to engage with their multiple identities, moving away from a taught-learnt model to something potentially far more complex: 'learning may be found to be, not only non-linear but perhaps fractal in its complexity. However inconvenient it may be, there is more to human interaction than the rational and the deliberate' (Bibby, 2009, p. 42).

A key aspect of this complexity is multiple existing identities which pupils struggle to hold onto as setting catalyses the dismissal of group memberships extraneous to mathematics. A focus on the mathematics appears to reduce the teachers' capacity to hold in mind pupils' wider identities. This is particularly true where the set-teacher is not the pupils' usual class-teacher, or, as was the case for a number of Avenue pupils, not a teacher of that year-group. Youell (2006) suggests that we belong to multiple groups some of which we choose and others which we do not, but all of which go towards building our identity and giving meaning to our lives. She highlights the complex web of interconnected groups pupils belong to through describing a typical primary pupil's day:

> 'A Year Five boy … starts his day by making the transition from family to school. In the playground, he waits with friends for the bell to ring and then lines up with his class group. After registration in his classroom, he goes to assembly, where he becomes part of the school as a whole, staff and children. Back in the classroom, the first half hour is spent in whole-class activity before dividing up into small groups to pursue particular tasks. Playtime arrives, and he plays football with a group of boys from Year Six until he is ejected in favour of one of their own peers. His class then join the other Year Five class for singing practice in the hall. Then he goes to the library with half of his class before going back to the classroom and from there to the dinner hall. He always shares a table with the same small group if possible, but today two teachers join them. In the afternoon there are science activities in small groups, before PE and then circle time with their class-teacher and, lastly, story-time on the carpet with a classroom assistant. The after-school club sees him sitting with a group of children from various classes, trying to get his homework done so that there can be no argument about him going out to play with neighbourhood friends after tea.' (Youell, 2006, pp. 105-106)

Youell argues that managing these different groups with their different rules and structures requires pupils to have a strong sense of who they are. This is difficult to achieve under normal conditions, but I would suggest that where teachers are less able to hold in mind pupils' wider identities and where setting physically relocates pupils from other groups, the task of identity maintenance becomes more onerous.

The particular issue appears to be not that individuals are not accounted for within sets (indeed, Boaler's, 2000b, study suggests a high degree of focus on individualisation) but that the attitudes accompanying sets fail to account for the relationships, intact or fractured, that pupils bring to the sets with them. Pupils' class and external relationships still remain even if momentarily broken for the duration of the mathematics lesson. These relationships are all part of the 'nexus of multimembership' to which Wenger (1998) refers and yet they appear to be ignored once the pupil enters the set classroom. This was exemplified by pupils who recounted incidences or talked about how events outside of the mathematics classroom had a direct impact on their mathematics lessons:

> "If it was after play and I had fallen out with my friend and then I had to go to maths I would feel a bit upset, because other things happen before the maths, it's not just the maths that makes me happy or sad."
>
> (Rhiannon, Avenue, Y6, S4, MA, 21.11.07, Lines 63-65)

In the following extract, Wynne talks about Mr Iverson, her Year 4 class-teacher, whom she is taught by for the majority of her lessons. However, as she is in Set 4 for mathematics and Mr Iverson takes Set 1, she is removed from her class-teacher during mathematics lessons:

> "Maths before lunch I'm not very good with because I am having bad lunchtimes and I have to go and tell Mr Iverson when I am feeling fine and when I am not. I normally like maths before break or after lunch, but not before lunch."
>
> (Wynne, Avenue, Y4, S4, HA, 20.11.07, Lines 68-71)

In both extracts, Rhiannon and Wynne elude to how external events impact on mathematics learning as they worry about these during the lesson. Mathematics, as Rhiannon notes, does not stand alone, 'because other things happen' but setting emphasises the tendency for teachers to act as if it does and as if it can be considered purely as a discipline. Wynne's extract suggests that Mr Iverson *is* engaged to some extent in a pastoral role in supporting her at lunchtime but that the constraints of setting make it harder to fulfil this role.

Whilst the discussion above refers to identities within the context of the school, pupils also bring identities from outside school. Within their individual interviews, pupils were asked to draw what they were thinking and feeling during mathematics lessons. The responses from two pupils at Avenue illustrate that pupils are thinking about more than mathematics (Figure 13 and Figure 14).

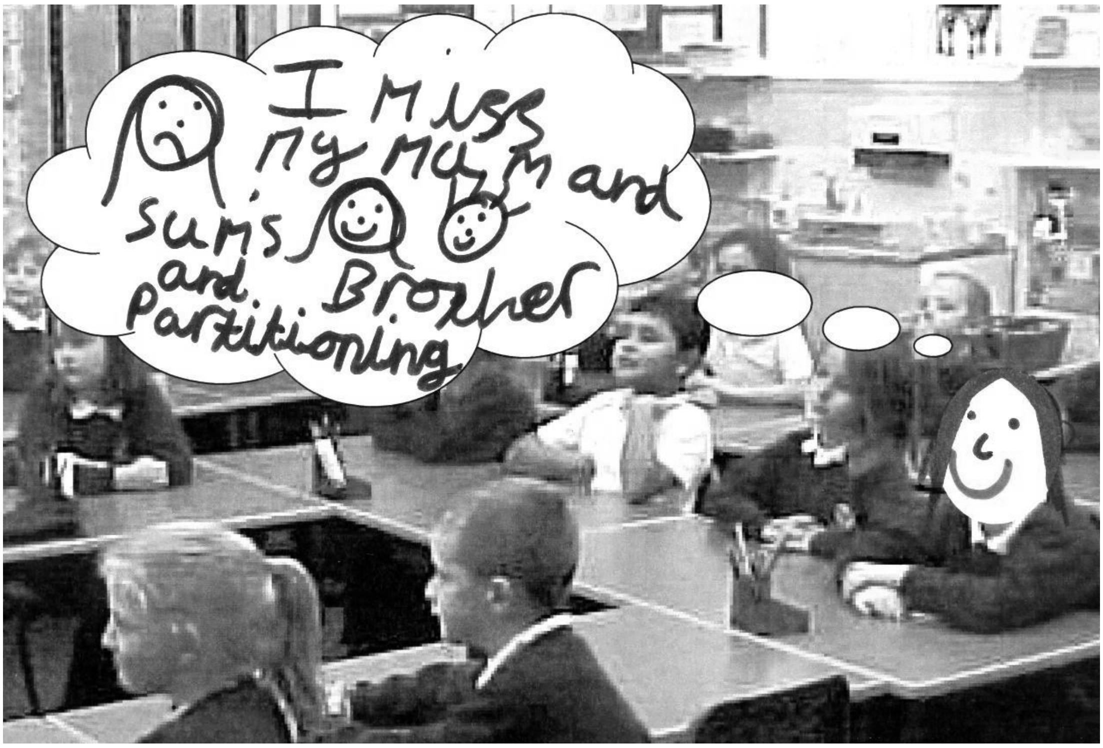


Figure 13: Feelings task – Yolanda (Avenue, Y4, S4, MA)

> Rachel: Okay, and can you tell me about the things you have drawn in your thought bubble?
>
> Yolanda: Sometimes I miss my mum and my brother, it's just sometimes that pops into my head in maths because my brother is quite cute and my mum always gives me cuddles. I miss that. Sometimes I think about sums in maths.
>
> (Yolanda, Avenue, Y4, S4, MA, 07.05.08, Lines 89-93)

Zackary's response may appear to be a diversion from the objective of the interview and the result of poor interview technique/questioning. However, given that Zackary was fully aware that this was an interview about mathematics and because the rest of his interview was in the context of mathematics, this distraction is helpful in understanding the intensity of the focus of his thoughts on issues outside of school mathematics:

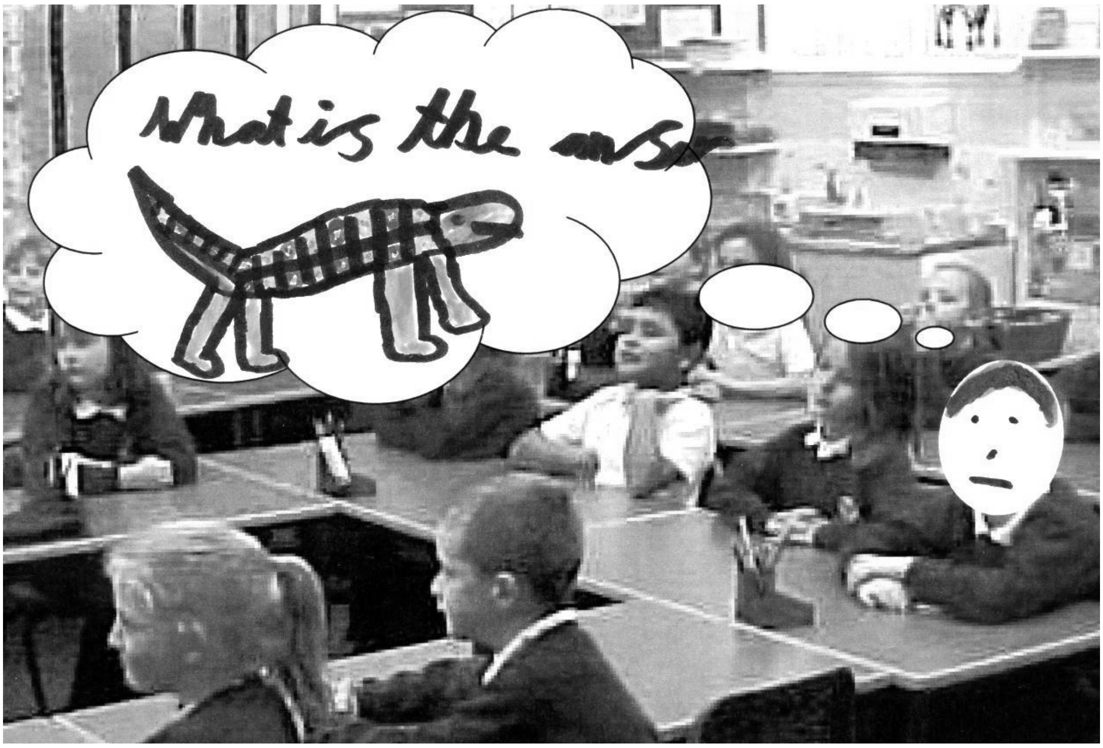


Figure 14: Feelings task – Zackary (Avenue, Y4, S4, LA)

Rachel: And now, in the thought bubble can you draw or write to show me what you might be thinking about in maths lessons?

Zackary: What is the answer and how to get there. And then there's this. I think about this all the time. It's not my best drawing; it's got a bit mixed up. It's a robot and it's in the Argos catalogue and it's called Pleo and it costs £250 but I'm still going to get it and I really really want it and it's going to be my biggest Christmas present ever and I'm only going to get that for Christmas and that's it. I'm thinking about it all the time, when I'm going to bed, when I get up in the morning. I think more about that than the maths. It's the most lifelike robot that anyone has ever made in the world. It makes noises, it interacts with you and it is exactly the same size as a baby komodo dragon. An adult komodo is about from the ceiling to down there and from about there to there but a baby would be about that and that's the size it would be. It took 4 years to make because they had to make the head the right size, but if they make it bigger that would increase the power but then in the motor there they would have to put more power in there and that would affect the leg power and that would affect the tail power. They had to work for four whole years, that's a very long time. I don't know if there will be a delay because it was supposed to come out in September but there was something wrong with its charger because it needs to be charged for 8 hours.

Rachel: And what about after Christmas, what will you be thinking about in your maths lessons?

Zackary: Well the same because you have to feed it and you have to play with it and if you don't it dies and the motors stop working. It's like a pet.

(Zackary, Avenue, Y4, S4, LA, 20.11.07, Lines 64-86)

Whilst focused on different things, Yolanda and Zackary foreground their discussion of thoughts within a mathematics lesson with non-mathematical elements. These thoughts may emerge in other lessons but it appears the mathematical focus and the limited pastoral support may make such thinking more likely especially where pupils struggle to perform a mathematical identity. Although a small quantity of school mathematics appears in each – 'sometimes I think about sums', 'what is the answer and how to get there' – the predominant focus is not school mathematics. Yolanda's background intensified the importance of her family relationships and yet setting constraints substantially reduce the possibility of the set-teacher engaging with the implications of these. Whilst the set-teacher had some awareness that these relationships Yolanda brought with her to the mathematics set may impinge on her learning, the lesson was still viewed very much as a discipline whereas more support may have been available to Yolanda had this been a class lesson taught by her own teacher.

In addition to an exclusion of their social identities, pupils may paradoxically experience a reduced engagement with mathematics due to a mathematical focus. Set pupils talked about feeling removed from the more secure foundations they built up with peers in their classes. Not having the support of trusted friends in set lessons reduced the possibility for collaborative learning:

"I think sitting with your friends actually helps because if your friends understand, we can actually do things together, it's like you can work it out with your friends, but if you're sitting with people you don't like or you don't know you're just sitting thinking 'I don't like you, you annoy me' rather than thinking about how to work things out; you're distracted."

(Olivia, Avenue, Y6, S1, LA, 30.01.08, Lines 135-140)

"When weren't split into groups in year 5, if I found something hard I would ask Mark to explain it to me and stuff and he were really good at maths. Because if he explained it to you he would explain it slowly so you kind of understood and every-time we had a maths test he would

> get every answer right and stuff and he were really good. He's not in my group now."
>
> (Delyth, Parkview, Y6, 21, HA, 13.11.07, Lines 81-85)

Olivia explains how working with friends established within her usual class could be beneficial to mathematics learning and gives an indication of why not working with peers she knows more may be a hindrance. Delyth also reflects on how setting has fractured a previously supportive relationship. The importance of being able to work with others involving more social rather than school-based interactions is what Boaler (2000a), drawing on Zevenbergen (1996), argues for, suggesting the need to consider not only the mathematics, but also the practices and environments in which learning takes place, all of which is part of doing mathematics and impacts on pupils' 'emergent mathematical knowledge' (Boaler, 2000a, p. 115).

A stronger mathematical focus may change the focus of pupils' identity work. Pupils are working with, and trying to bring together, different group memberships. However, teachers' mathematics approaches may fail to account for this and only pertinent school-mathematics work is 'seen'. In the same way that teachers switch-off the world outside of mathematics, they expect the pupils to be able to do the same, and the most successful mathematics pupils are considered to be those who can compartmentalise, or at least project an image of having compartmentalised, their identities. This is illustrated below where Uma and Victoria are talking about blocking out external thoughts as a reason for pupils doing well in mathematics:

> Uma: And thinking, I think that comes here. If you're thinking you might work harder.
>
> Victoria: But you might be thinking about something else.
>
> Uma: Well thinking about the lessons. Thinking about things that aren't the lesson won't help. We're in the top-group because we're not always thinking about other stuff.
>
> Victoria: If you're not thinking about the lesson then you're going to get it wrong. Because most people who talk a lot, that's like me, but then when it sort of comes to the lessons I pay attention. Paying attention, we can put that on as well.
>
> Uma: Also I think you should try and, you know, if you have an argument at playtime, you should try and forget about that while you are lining up because otherwise your mind will be buzzing round with 'ooh, maybe they're not my friend any more, will they be my friend at lunchtime because of what

happened today', you have to try and forget that and instead focus on the maths, focus on the lesson.

Victoria: Yeah, you have to try and forget about anything that is worrying you. Worrying things.

(Avenue, Y4, S1, 06.05.08, Lines 10-24)

This extract sits in contrast with those of Rhiannon and Wynne earlier who dwelled on the things Uma and Victoria recognise as counter-productive to the mathematics lesson, namely social relationships outside of the mathematics classroom. Pupils' perceptions of the identity-work required to be successful within a mathematically focussed set brought with it a sense that they had to numb their identities, presenting a very bland version of themselves in order to survive the mathematics classroom. This came across in Ben's interview when he talked about how he acted in mathematics lessons as he completed the feeling picture task (Figure 15):

Figure 15: Feelings task – Ben (Parkview, Y6, S1, MA)

> "I'm kind of, not happy or sad, just kind of straight like this. Well sometimes I don't really really act, because if I say "ahhhh", she says, come on, don't do that, and I don't want to stand out ever even if I'm really happy, so I make no reaction and she doesn't say anything and I just get along with my maths. I really don't want to stand out, I just don't … If I don't try to stand out, the teacher, she doesn't say anything, which I guess is my plan, it's like what everyone does."
>
> (Ben, Parkview, Y6, S1, MA, 27.11.07, Lines 97-106)

Ben was considered to be quite successful in mathematics, yet he talked repeatedly about not wanting to stand out and having a 'plan' to avoid this. Ben's teachers talked about him being very different outside of mathematics which I observed in my year at Parkview, but in mathematics he seemed very subdued, possibly in his attempts not to stand out. Having such a plan, and actively working on it, would inevitably, whether Ben is aware of it or not, take time away from the mathematics which he says he just wants to 'get along with', suggesting further how the teachers' view that it is 'just maths' may impact on pupils' leaning and engagement.

In addition to the mathematical focus, setting brings with it wider consequences as a result of its organisational features which appear to go unnoticed. Whilst it is usual for secondary pupils to move around for lessons, experiencing different teachers and classrooms, setting is an unnatural process for primary pupils. Without an awareness of pupils' strengths and weaknesses over a range of subject areas it is harder, Noddings (2003) argues, for teachers to achieve a position of care; a result not of teacher failure, but of structural failure. Pupils in primary schools may have stronger class relationships with their peers then those in secondary schools and these relationships are disrupted through setting. It is important to note that the impacts of setting discussed in this section extend beyond the time of the actual set mathematics lessons. At Avenue, and on occasions in Year 6 at Parkview, the beginning of the day, when classes were registered in their classrooms, did not resemble the more traditional beginning to the day of a primary classroom but a rushed and stressful time as teachers attempted to settle the class and deal with the necessary daily administration tasks – such as taking the registrar, collecting dinner money, etc. – before pupils had to move to other classes for set mathematics lessons and before other pupils arrived, often in a restless state, outside of the classroom.

The rushed start to the day where setting was in place contrasted sharply with both Year 4 classes at Parkview where a lack of setting removed these immediate time pressures and constraints. Whole-class pastoral issues could be given time, as required, and I observed mathematics lessons which were continued into the next lesson or after break-time when pupils were particularly absorbed with the lesson content. Setting, and the movements and time restrictions it imposes, fractures the traditional teacher-class/pupil relationships removing opportunities to deal with, for instance, pastoral issues which may impact, directly or indirectly, on pupils' learning in mathematics; either in terms of understanding these or communicating them to the set-teacher. Whilst only with a small sample and difficult to generalise from, I sensed a difference on the few occasions when Avenue pupils were being taught mathematics in their classes. Here, teachers were not time-constrained in completing their administrative tasks and pastoral issues could be explored and addressed or accounted for within lessons; the whole class atmosphere seemed more relaxed with the teachers appearing happier to discuss, for instance, aspects of their intended lesson with me. In comparison with set lessons where the focus was in getting the pupils in and starting the lesson as soon as possible, the difference seemed quite extreme and this negation of a pastoral focus and a rush towards a subject focus may underlie, in part, pupils' views that teachers are unaware that there is more to mathematics lessons than mathematics.

Rather than being unaware of the wider-identities pupils brought to mathematics lessons in sets, organisational features of these lessons may have dramatically limited the opportunity for any other approach. Although teachers did talk quite abstractly about mathematics when talking about teaching in sets, some understood the neglect of a whole-class pastoral focus when teaching in sets:

> Rachel: Would you say there are any other advantages to doing maths as a class rather than setted?
>
> Mr Donaldson: Well it's, I don't know, it's got more, they're your children, they're your class and you know where they are across the curriculum and you know, I think that in itself can help me to understand, you know where to push them on a little bit more, but if you see them for an hour every day it's just more difficult.
>
> (Mr Donaldson, Parkview, Y4, 21.07.08, Lines 162-167)

Here, the difficulties associated with not having an opportunity to engage fully with each child in terms of their development across the curriculum when contact is limited to set time are acknowledged. Mr Donaldson talks about being better able to understand the pupils in his class when he sees them across curriculum areas. This benefit of retaining class teaching is also highlighted by Osborn et al. (2000, p. 171) who suggest that pupils moving into different sets and groups weakens a long-established single class teacher–class link, reducing and redefining the nurturing role of practitioners and removing an 'important element in the intuitive understanding and formative assessment of each pupil.' Hence, whilst setting may increase the ability-identity positioning work pupils are doing, simultaneously it may be reducing opportunities for teachers to conduct useful and informative assessment practices. Further, setting may increase the focus on summative and high-stakes style assessments as such assessments may be seen to fit better into the constraints and requirements of setting structures.

For interactions such as those described above to change there needs to be a change in how teachers view what happens in their sets. As Lerman (2009, p. 155) notes, '[e]nvisaging the process of induction of each student into the mathematics classroom as gaining a school mathematics classroom identity may focus the teacher's attention on the whole person and their becoming, rather than part of the person and their knowing.' However, given everything that has been said above, the changes may need to be deeper or just different in the primary school where classroom reorganisation is only used for some lessons, and often just mathematics, and as such may have deeper implications. There is a need for clarity about the purpose and objectives of primary education and for this to be clearly communicated to all: teachers, pupils and parents. There is an assumption in England that pastoral care and the consideration of the child's welfare is central to the role of the primary school teacher (Broadfoot, Osborn, Gilly, & Paillet, 1987). Calvert (2009), through an historical examination of pastoral care and care issues in schools, notes the extent to which this is a UK phenomenon and part of our culture. As a result, any shift from this, as appears to be happening during setting in mathematics, creates mismatches in how teachers understand and perform their role and in how pupils understand or rationalise what is happening. In primary education systems such as those in France and Russia where the focus is solely on the mathematics and not on pastoral issues (Alexander, 2000; Osborn, 2001) and where this is part of the cultural tradition (Audiger & Motta, 1998), such a mismatch does not appear to occur. The difficulty appears to arise for us because pupils and teachers are dealing with a change to their established roles and expectations brought about as an indirect consequence of setting.

Within this section I have examined how setting may lead to teachers having a greater focus on mathematics and a lesser focus on the whole child. I have explored how this may result in pupils feeling parts of their identities are ignored with some pupils having to do more identity work. It seems important that we find a way of allowing teachers to account for the 'complex and diverse network of influences, that determines the "unique" way in which [pupils] find themselves and look at the classroom context' (Op't Eynde, De Corte, & Verschaffel, 2002, p. 22) in order to minimise the indirect negative impact of ability-practices on the learning of mathematics.

9.4 Space Allocation

The identity work discussed above takes place within the context of multiple relationships with peers, teachers and beyond. I looked at the impact on pupils of being removed from the pastoral support of their class-teacher. This removal has further ramifications. Setting requires, for many pupils, removal from one environment – their usual classroom – and placement into another for their mathematics lesson. Classroom change is particularly pertinent in the primary context where the pupils' classroom is not just a base as in secondary schools but the centre of their education and relationships with others for an entire year. Removal from this environment for setting, although only temporary, is likely to impact further on the identity work already taking place as pupils work to develop a sense of where they belong. Whilst inclusion is defined in terms of where pupils can develop a feeling of belonging rather than in terms of an actual location (Warnock, 2005), I would argue that the physical location is important as it sends messages to the pupils about how they are perceived and impacts on their feeling of belonging.

Whilst there have been some studies (e.g. Clark, 2002; Durbin & Yeshanew, 2010) into the impact of school buildings on pupils' learning and well-being, an issue brought to the fore through the previous Government's Building Schools for the Future (BSF) programme, these have tended to be architectural in focus. They have predominantly considered the impact of the whole-school design rather than the effect of specific areas or the allocation of space within the building. Space within the school, McGregor (2004) argues, is such a taken-for-granted concept that it has not been considered extensively in educational research, hence, with the exception of some learning environments research in Australia, the literature is limited. This lack of consideration appears to filter into teachers' practices, where there is very limited consideration of the impact of physical space on pupils' learning (Fisher, 2004).

Despite this lack of consideration, space is recognised as an important component in pupils' learning. Scott (2001) draws on situated-learning approaches in examining how different forms of structuring impact on learning. He notes how all aspects of structures, which I suggest includes the physical location, impact on what is learnt and on the transfer of that learning to different contexts. An argument for acknowledging the physical location is made by Paechter et al. (2001, p. 1) who suggests that as well as looking at the impact of space on learning we need to question 'how we as embodied individuals are changed by our experiences in these spaces.'

The literature on space in schools tends to focus on two levels: a macro-level looking at the impact of whole-school buildings and assignment to particular schools for instance where grammar schools select pupils (e.g. Armstrong, 1999) or a micro-level considering assignment, for instance, to table-groups within the classroom (e.g. Dixon, 2004). I explored these issues in Chapter 8. Although these studies do not consider a level in between, that is the allocation of workspaces, their conclusions, that different places 'can directly support or inhibit learning' (Clark, 2002, p. 9), that 'students learn better when they perceive the classroom environment more positively' (Dorman, 2002), and that 'staff and pupils can be profoundly affected by where they are in the school and the behavioural expectations created by that environment' (McGregor, 2004, p. 15), are relevant to classroom allocation and the impacts of allocated spaces on pupils' identities.

One consensus across the literature is that the implications of space extend beyond the physical locations; in many cases, the space allocation is about the maintenance of power relationships. The division and allocation of spaces allows for the reproduction of social structures (Armstrong, 1999) and the establishment of social orders (Fisher, 2004). This has been considered extensively within Human Geography, but not in educational studies. This seems to be an oversight, particularly given that much of the educational literature, not least the setting literature, considers the implications of multiple practices in maintaining power relationships. In this section, I begin to address this gap, using my data to present a hypothesis concerning the potential implications of the spaces allocated as part of setting processes.

Avenue use setting to provide smaller groups for some pupils through the creation of more sets than classes; the three classes of each year-group are split into four unequal sized sets. However, Avenue does not have the physical space in terms of spare classrooms to accommodate such arrangements, leaving some pupils without a stable base. In both Year

4 and Year 6, it was the bottom-set, set 4, who were not given a stable base within their year-group classrooms. I reflected on the impact of this in my Research Journal:

> I was struck today by the potential implications of the spaces given (or not) to different sets whilst working with Year 6, Set 4. The pupils in Sets 1 – 3 moved from their registration classrooms to one of the Year 6 classrooms in the Year 6 corridor to begin their lesson, probably resulting in no more than a 5 minute gap between leaving registration and starting their lesson all the time retaining a physical position related to 'being Year 6'. However, Set 4 pupils had to 'hang about' in the corridor waiting for the teacher to tell them where the lesson would be and to walk them there. This in itself seemed quite exposing as other pupils moving classes saw these pupils leaving the Year 6 classrooms, but not going back into a classroom on the Year 6 corridor. Today, the Set 4 pupils were using one of the Infant school's external Resource Base (SEN) rooms for their lesson. Given the location of this room, the size of the school and the recent conjoining of the Infant and Junior Schools, this involved a fairly lengthy walk through the entire Infant school including the Nursery area and outside to the Resource Base building. As the pupils were walking through the Infant Department, they were chastised by the Headteacher for 'not being where they belonged'. Although the teacher explained that they were timetabled to use the Infant Resource Base I wondered what impact both seeing themselves as out of place and being made to feel wrong for it had on the pupils. Additionally, being a room designed for the Infant section of the school, the tables and chairs in the room were unsuitable for Year 6 pupils, not only making learning uncomfortable, but possibly giving the pupils messages about not being entitled to a suitable classroom or that an Infant classroom was more suitable. About three-quarters of the way through the lesson we were disturbed by an Infant class who had precedence to use the room, and we had to decamp to the behavioural withdrawal room next door. This potentially sent further messages to the pupils about the value of their mathematics lessons (the behavioural room was not equipped as a teaching room with no desks, chairs or whiteboard) and possibly about the pupils themselves.
>
> (Avenue, Y6, S4, 29.01.08)

In thinking about the journey these pupils made, I mapped this on to a plan of the school (Figure 16). This emphasises the extent to which these pupils were removed from their Year 6 peers and highlights many features, including the walk through the infant department, which may impact on their understanding of themselves within and beyond mathematics. Although this is an extreme case with several incidents occurring cumulatively, these issues were not unique. Year 6, Set 4 pupils were regularly exposed to their peers as different, as for *every* lesson I observed, they were taught in non-year 6 bases and regularly not even in classrooms, using a variety of resource bases, ICT rooms and corridor spaces. There was a feeling that they were being accommodated and managed rather than going to a lesson. The uncertainty over which room they would be in and its suitability for the lesson caused anxiety for the pupils (and possibly the teacher) and disruption to the lesson with a regular comment from the teacher being "now I wonder where that is in this room."

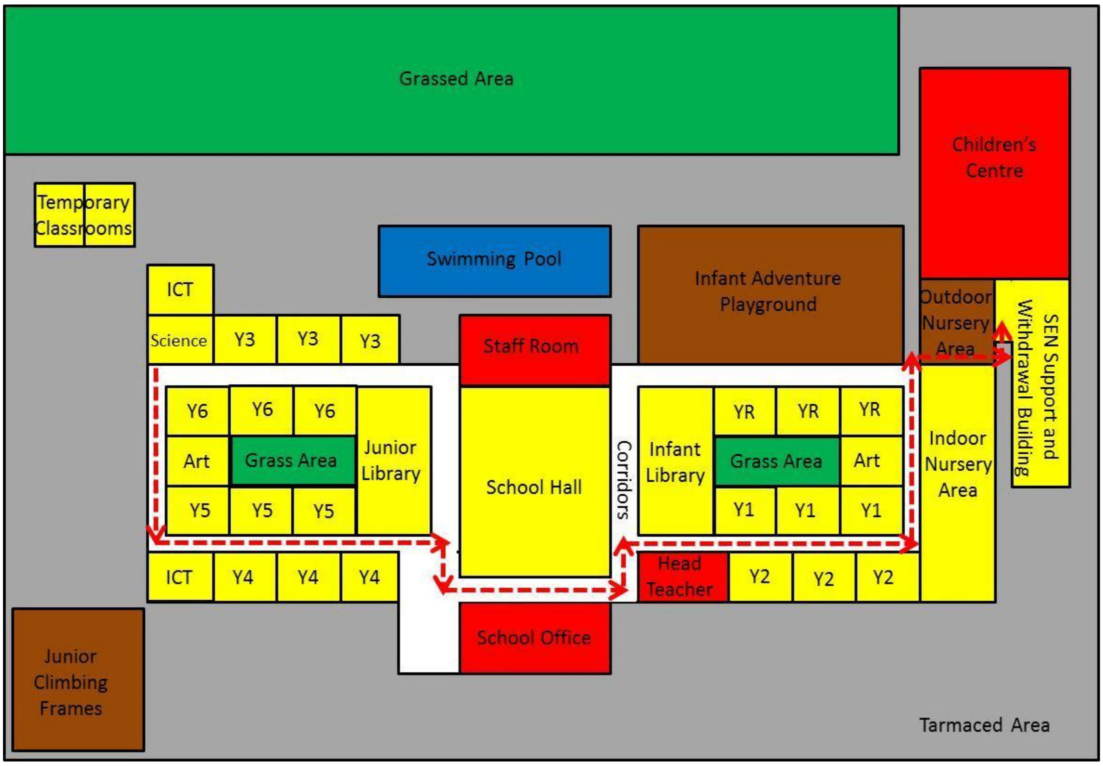


Figure 16: Set displacement – Avenue Year 6, Set 4

My journal notes reflect my perceptions of the events but this is ratified by the pupils' interview data. In this extract, I was talking to Sam about his typical mathematics lessons. I asked him about being given homework to move the discussion on to the final section of the lesson at which point he brought up the subject of room changes:

> Rachel: Okay, and then finally you are given out your homework?
>
> Sam: Yeah, we go into the other room, cause when the year 1 comes they want the room we're in and we have to go to another room and it's just not helpful, like if you have been learning maths in one room, and you learnt it, if you have to move somewhere else new and you're not really good at maths it just, I get a feeling, I don't like that, it's harder.
>
> (Sam, Avenue, Y6, S4, LA, 04.03.08, Lines 92-97)

Sam talks about the impact of changing rooms on learning mathematics. My observations of this set suggested that once they transferred to the behavioural withdrawal room for the final 15 minutes, very little mathematics learning took place. This room was not a classroom and was not furnished with typical classroom paraphernalia. Instead of tables and chairs there were floor cushions and soft furnishings. There was no whiteboard, no pens and pencils and no mathematical apparatus. These changes resulted in pupils cumulatively missing a large proportion of their mathematics teaching time in addition to the time missed in walking to the classroom from the Year 6 corridor.

Mr Leverton, the Set 4 teacher, was aware of some of the difficulties presented through unsuitable spaces and occasionally sought out alternatives. However, no purposely designed classroom space was available. The nearest these pupils came to having a classroom were the temporary classrooms situated in the playground. These Portakabins had no sound or temperature proofing and were filled with furniture no longer required elsewhere, having science stools with regular tables. It was likely that this environment, which was uncomfortable to me and, I suspect, to the pupils, impacted on the pupils' sense of worth and potentially contributed towards some negative behaviours seen in this group. Mr Leverton talked about Sam's volatile behaviours and self-exclusion from the lessons:

> "As you saw a lot of times, if he wasn't switched on it was a very very difficult time for him, because he just said 'I'm not doing it' and you could, there was no point in blasting him because it didn't work, and if you did that he was quite likely to get up and walk out."
>
> (Mr Leverton, Avenue, Y6, S4, 16.07.08, Lines 55-58)

I observed Sam angrily leaving the classroom on a few occasions; once was during a lesson in the temporary classroom after Sam had, I would argue reasonably, complained about the heat repeatedly. Whilst Sam's anger appeared to predominantly stem from having his needs ignored, these needs may not have arisen had he been taught in a purpose-built classroom. Sam's behaviours contributed to his low-ability production. Had Set 4 been assigned a stable purpose-built classroom with the same access to facilities as other sets, some of the negative behaviours may have been reduced, potentially resulting in the development of more positive learner-identities.

The use of inconsistent classroom spaces results in Set 4 pupils facing the greatest degree of change. Youell (2006, p. 75) suggests that all children experience difficulties in coping with the transitions that make up the school day, but that children who experience the most difficulties in school 'simply cannot manage it.' At Avenue, the pupils who find change most difficult have the most changes to cope with. Not being able to cope is seen as symptomatic of their difficulties, feeding into productions of the child, rather than acknowledging that these pupils have to cope with greater levels of change. A different environment would not mitigate all the difficulties faced by this set, but there is a case to be made for considering the impacts of space allocation.

Similar experiences were also prevalent in Year 4 for Set 4 at Avenue. Although this group could remain in a Year 4 classroom when another set was using an ICT room, they also experienced comparable displacements out of the Year 4 corridor and into ICT areas, corridor spaces or Year 3 classrooms. Again, the beginning of the lesson was taken up with gathering up the pupils and walking them to an ever changing location. Rationalising these movements took up much of pupils' preoccupations:

> Rachel: Okay, what I want to start with is to talk about the different groups you go to for maths.
>
> Wynne: Well sometimes we, if it's, if we're in the same classroom, if we're in a different maths group that has to go in a different place we go in that classroom but sometimes we go in the science area or 3A, because, well, 4J, that's our maths teachers' classroom and so we just go in there but I don't really know why and sometimes Mr Hockins' maths group goes in Mrs Jerrett's room and so we go to the science and computer area but then Year 3 have computer time so we go into 3A.
>
> (Avenue, Y4, S4, 30.04.08, Lines 1-8)

> "You know we're not normally in the classroom we were in today. Sometimes we go round there in the science area or sometimes we just go in the corridor, because in our classroom, usually someone else has Mrs Jerrett's classroom, we only go in Wednesday and Thursday in the classroom, the other days we go to like the science area."
>
> (Zackary, Avenue, Y4, S4, LA, 20.11.07, Lines 103-107)

Wynne and Zackary both highlight the complexity of movements these pupils are involved in. There is again a suggestion that their place is not stable. The teacher and pupils would walk to the anticipated location of their lesson only to find that the room/space was already in use by another class. As with Year 6, Set 4, not having a base meant limited access to mathematical equipment. In both years 4 and 6 at Avenue, pupils in Sets 1 – 3 were taught in classrooms where they had ready access to supporting equipment, mathematical displays and aids such as number lines on the walls. Set 4 pupils only had what the set-teacher could carry, reducing the opportunity for spontaneous exploration of concepts, and were taught in areas where the displays related to other subjects, serving as a distraction rather than a potential support for learning. As a result, Set 4 pupils were more limited in their learning opportunities due to the physical constraints imposed by setting, potentially increasing the attainment gap. This limitation was raised by their set-teacher who felt the physical spaces constrained the approaches she could take:

> "In our group we could have done more get up and do except in that computer room there isn't a lot of space and you know in the corridor you're a bit constrained and a bit public as well because everyone is walking through."
>
> (Mrs Jerrett, Avenue, Y4, S4, 16.07.08, Lines 93-95)

Whilst space issues were extreme for Set 4 pupils at Avenue with learning environments not fit for purpose, Set 1 pupils at both schools also experienced issues related to space. To allow for smaller lower sets, there were more than 30 pupils in each top-set. However, these sets were taught in classrooms designed for 30 pupils. This resulted in difficulties physically fitting them in and initial disruption to the lesson finding chairs for everyone. Whilst this is unlikely to have the same impact as the multiple space related experiences of Set 4 pupils, it is important to consider these impacts when looking at issues of space. This issue was particularly acute for Year 6, Set 1 pupils at Parkview. Here, the top two sets were combined within one classroom resulting in severe overcrowding. Pupils, squashed around tables, were not physically comfortable and it was very difficult for those at the back to see the board. These issues potentially impacted on their learning and physically constrained possibilities for collaborative work. The issues created by a lack of physical place to meet the perceived need for practices predicated by an ability ideology suggest how widespread the impacts of ability can be, with so many elements of the school day, not just the mathematics teaching, being impacted.

Space issues also relate to specific groups of pupils such as those with Special Educational Needs (SEN). Although Avenue was developing designated provision for SEN pupils during the year this research was conducted, the issues raised here did not appear to be considered by the school. At Avenue, pupils with diagnosed or suspected SEN were usually assigned to Set 4; whilst the sets were named by number, it was not unusual to hear teachers refer to Set 4, sometimes in front of pupils, as the Special Needs Set. Placing SEN pupils within bottom sets was part of the set allocation practices at both schools, a practice Montgomery (2009) and Lupart & Toy (2009) suggests occurs across many schools despite the 2007 recognition of 'dual or multiple exceptionality' within the National Strategies which cover mathematics (Devi, 2010). Although opportunity for set movement was limited for all pupils, SEN pupils were less likely to move as a result of teaching assistant (TA) allocation. In both Years 4 and 6 at Avenue, TAs were only assigned to Set 4. At Parkview, where a large number of TAs were employed, it was usual in Year 6 that only one would be allocated to the amalgamated top-set, whilst a large number would be present in Set 2. On one occasion when I observed Set 2, the number of adults in the room outnumbered the number of pupils. Due to the positioning of TAs, if a pupil required or was allocated support, they had to be taught within these bottom sets. There was no opportunity for TA support in higher sets at Avenue and limited opportunity at Parkview. These placements reflect the literature where 'TAs hardly ever supported middle or high attaining pupils' (Webster et al., 2011, p. 11).

Issues of space went beyond setting for some SEN pupils at Avenue. In Year 6, two pupils – James and Jack – both with statements of SEN – were deemed to be working at a level below which they would benefit from Set 4 placement. These pupils were not given *any* placement in Year 6 mathematics sets, but were sent to Year 5, Set 4, for mathematics. As with the Year 6, Set 4 pupils who were exposed in front of their peers as different for not entering a Year 6 classroom, I became aware of some, often whispered, negative comments regarding these pupils as they walked towards the Year 5 space. These were voiced during a group-interview in which Sam raised a concern about the assumptions made about James and the educational implications of this:

> Sam: James isn't in the bottom-group. He has to go to year 5 to do maths.
>
> …
>
> Sam: But I get a feeling, and I don't think it's a good feeling, you know a boy called James, he like a bit, he's not okay.
>
> Rhiannon: He has behavioural problems
>
> Sam: He's a bit mad. And I don't get it - all the teachers in maths they put him in the computers and don't give him any work, and he *can* do the work, it's just that he can't be bothered and they think that he can't do it, but I was teaching him yesterday and he did it all on his own. I've got, well it's just not right.
>
> (Avenue, Y6, S4, 06.01.08, Lines 300-306)

Whilst I did not interview James or Jack, I would conjecture that this physical displacement may have impacted on their mathematical identities in many similar ways to the lack of place experienced by Set 4 pupils. A similar situation also occurred in Year 4. Here, one statemented pupil – Rebecca – was deemed incapable of accessing the standard curriculum. Rather than being allocated to a lower year-group she followed an individual programme of study under the guidance of a TA at the back of the Year 4, Set 4, class. Recent research (Webster, et al., 2011) suggests that such practices cause a separation of the pupil from the teacher, something which was certainly seen in this case. Further, greater TA support has been found to result in lower attainment (Blatchford et al., 2011); this has implications not just for Rebecca but for other pupils in this study receiving higher levels of TA support. Again, Rebecca was not a focal-pupil but I would suggest her allocated place carried multiple implications for identity development; both the same issues faced by Set 4 pupils in not having a stable base and specific issues in being sat at the back of the classroom fully aware of the lesson taking place, but not included in it.

A further group of pupils facing issues related to space were those with English as an Additional Language (EAL). As with statemented pupils, these pupils, where their language needs required TA support, were automatically allocated to bottom sets, regardless of mathematical attainment. In many cases their mathematical attainment was not accurately assessed on the same basis as other pupils as they could not access the tests used due to language difficulties. As with SEN pupils' set allocation, the allocation of EAL pupils to Set 4 has been noted to occur more broadly across primary schools (European Agency for Development in Special Needs Education, 2009). Teachers showed some awareness of the issues surrounding this practice:

> "Quinn, see in her own language she was, she would have been, she was very good at calculation when it became looking at a problem, working her way through it, I don't know how much work she had done on that, and of course then you get the different types of language so she couldn't access the paper … because of the language, she's going to be there, which is disappointing but it's purely because of the language if it was in her own language she would be much further up."
>
> (Mr Leverton, Avenue, Y6, S4, 16.07.08, Lines 15-22)

The issues created by allocations to limited physical places on the basis of perceived ability differences suggest how widespread the impacts of ability can be. However, it is important to note that the issues raised in this section are conjectures based on fairly limited data and there is a need to explore this further before making any firm assertions about what is happening for these pupils.

9.5 Chapter Conclusion

This chapter extends our understanding of the impacts of ability through highlighting some of the implications of ability-predicated practices less often discussed in the literature. In many cases, these are impacts which teachers are not aware of. It has suggested how ability can have multiple impacts on pupils, well beyond those we expect. This chapter makes it clear that if we want to understand and change ability-based teaching approaches, we need to look at impacts beyond those directly attributable to ability-grouping. Bibby et al.'s (2007) study noted that the classroom environment and responses to it play a pivotal role in shaping a pupils' mathematical learner identity. I would go beyond this, suggesting that ability discourses, themselves part of mathematical learner identities, shape the classroom environment pupils find themselves in, resulting in a duality of impact on identity formation.

One issue I wish to emphasise is that teachers are not partaking in these practices with the intention of the consequences noted here. These are unintended and often unnoticed consequences. The schools generally came across as trying to do the best for all pupils. Their intentions were to be helpful, often through what they saw as protecting pupils, for instance through reducing set sizes and allowing some pupils to learn away from others. What this chapter does is highlight, again, how pervasive ability is and how far reaching its impacts can be.

This and the previous chapter have demonstrated how common primary classroom practices may produce and develop understandings of ability. Pupils caught within these practices are all engaged in identity work, whether subduing aspects of themselves in aligning with the mathematical focus of the set classroom or trying to make sense of their physical placement. Other identity-work is more closely linked with people than places or practices. In the following chapter I explore the co-constructive work – particularly between pupils and teachers – taking place in the primary mathematics classroom and its role, alongside issues such as those discussed in this chapter, in reproducing pupils' understandings of mathematical ability.

10 The Reproduction of Mathematical-Ability

10.1 Introduction

The previous chapters have explored pupils' beliefs about ability and the pervasiveness and wide-ranging impacts of a discourse of ability in the primary mathematics classroom. This chapter takes this understanding forward, looking at the processes occurring that allow the dominance of ability to continue. This chapter uses qualitative evidence to examine how pupils, teachers and the practices of the primary mathematics classroom support the reproduction of ability and debates the potential implications of this. In doing so, it brings in and extends two quantitative based regularities identified in chapter 6: reproductive identity work at play in making judgements about pupils' ability are considered in understanding the processes leading to set placement overlap as identified in section 6.2.1. Further, section 10.3.2 examines the reproductive practices of bottom set teaching and learning which may contribute to the widening attainment gap, occurring within a process of educational triage, identified in section 6.2.2.

This chapter is particularly concerned with the co-constructive processes of identity development, investigating how pupils, teachers and/or practices may work together to sustain ability labelling, through deliberate actions or through 'everyday' actions which may go unnoticed. It also examines reproduction from a historical approach, exploring the extent to which teachers reproduce their experiences with mathematics, hence limiting possibilities for doing things differently. This chapter is particularly important in helping us understand how things continue, and why, as discussed in the following chapter, change and transformation of ability may be so limited.

10.2 Sustaining a High-Ability Identity

The axial-coding suggested four themes which make up high-ability performance: displaying ease of working, positive learning behaviours, pro-school classroom behaviours, and getting away with misbehaviour. Pupils engage with ability productions on a daily basis in the mathematics classroom, performing the label they or others see them to be. These enactments sediment understandings, reproducing 'taken as shared' beliefs (Yackel & Rasmussen, 2002, p. 316) of particular ability productions. This section is concerned with how pupils are helped in this performance, and hence how ability is reproduced, by teacher co-construction and classroom practices.

There was some evidence of pupils not working in co-constructive relationships (either with peers or teachers) when performing aspects of their ability-identity. In the following interview extract Thomas was talking about a behaviour he or others could engage in that may lead to teachers judging them as being high-ability:

> "Maybe the teachers judge it on putting your hands up, because sometimes you can put your hand up because you know the teacher is not going to pick you."
>
> (Avenue, Y4, S1, 07.02.08, Lines 199-200)

Thomas suggests this behaviour may be seen as an indicator of knowledge and understanding, but acknowledges that this behaviour can be managed and used to strengthen an ability identity. He suggests that it is possible to engage in the behaviour in order to gain a high-ability status, but with this being a safe behaviour because he knows he is not going to be called upon by the teacher to demonstrate the knowledge or understanding. Whilst this is an individual behaviour on Thomas' part, it still involves teacher input and could still be thought of as co-constructive. Other identity work was more explicitly co-constructive, as discussed in the following section.

10.2.1 Teacher and pupil co-construction

Some co-constructive work occurred between the teacher and the whole class, with the teachers' actions reproducing an understanding of what it meant to be high-ability. For instance, speed of working came across intensely particularly when turned into something negative, with a lack of speed associated with not performing a high-ability identity. In one lesson, teacher reprimands included reference to speed:

> "Have you done it? No? Then you need to open your book and close your mouth. Quick, quick, quick, you're wasting time." The teacher picks out pupils who have finished as "good".
>
> (Avenue, Y4, S1, 11.12.07)

This incident, through the references to being quick and wasting time, drew the pupils' attention towards the value put on speed and strengthens a link between this and being 'good', even though good is left undefined as mathematical or behavioural. Many such incidents appeared to focus on classroom behaviour, rather than mathematical, aspects of what was considered high-ability. In one observation (Parkview, Year 4, Class 2, 07.12.07) the class-teacher stopped the class, picked up a number of pieces of work from pupils in different groups and asked the class which was the easiest to read. Given the choice of pieces, this was a rhetorical question designed to elicit a positive response towards the work produced by a pupil in the top-group. Having received confirmation that this was the easiest to read, the teacher, without checking to see whether the mathematics was correct, emphasised to the class that they needed to work neatly if they were to produce good maths work. Whilst it may be true in some cases that working neatly and/or methodically could be an asset to mathematical work, the link is being drawn out rather differently in the primary mathematics classroom with a non-mathematical behaviour being reinterpreted as an indicator of high mathematical-ability.

Whilst the above incidents relate to the teachers' interactions with the whole class, much co-constructive work was with individuals, but enacted so that the whole class accessed a reproductive message. This was particularly true with the enactment of pro-school behaviours. Pupils' productions of high-ability involved "not messing around" (Megan, Avenue, Y6, S1, 11.12.07, Line 11) and "never doing nothing bad" (Ivy, Parkview, Y4, Class 1, 22.11.07, Line 13). Teachers' everyday interactions intensified these productions for instance in asking for some "sensible children" to hand out the books and immediately choosing pupils labelled as high-ability (Parkview, Y4, Class 1, 03.03.08), whereby the teachers' actions may signal that being "sensible" was in some way related to their high-ability position.

Whilst the above was entirely about behaviours, much co-constructive work was messy, reproducing behavioural and mathematical elements of a high-ability identity:

> The class are working on fractions, identifying fractions of shapes and naming different fractions put up on the interactive white board. Pupils are only required to count the number of shaded blocks and the total number of blocks in giving their answer, for instance 3/6, rather than consider equivalent fractions. The shape on the board shows 2 out of 4 blocks shaded. The teacher writes this up as 2/4 and then asks George [high-ability labelled focal-pupil] how we should say 2 over 4. Initially, and quite audibly – I am sitting on the other side of the classroom and the answer is clear – George replies two fourths. Apparently looking for the answer of two quarters and so hearing this answer as incorrect, the teacher says he can't hear the answer because other pupils, pointing out two labelled as low-ability, are talking and he will have to wait for quiet, drawing attention to this behaviour rather than to the incorrect answer.

> He then returns to George, saying "I think what you said was two quar…" funnelling the response which George picks up on, giving the expected answer of two quarters.
>
> (Parkview, Y4, Class 1, 15.01.08)

In this extract, George and the teacher work together reproducing two distinct identities: a high-ability identity characterised by correctness and a low-ability identity characterised by talking and anti-school behaviours. This interaction is suggestive of Holland et al.'s (1998) improvisation as the teacher supports George's identity work through unplanned 'extensive teacher prompting' (Doyle & Carter, 1984, p. 132) and funnelling (Bauersfeld, 1988) to ensure correctness whilst additionally drawing other pupils' attention to the misbehaviour of another pupil. Similar uses of co-construction were also observed:

> The teacher asks the class: "What are we doing if we multiply by 1000?" A high-achieving pupil within the set talks about moving the numbers 3 places to the right. The teacher, although this is incorrect, says: "Yes, we move the decimal point to the right." This makes what the pupil says appear correct.
>
> (Avenue, Y4, S1, 11.12.07)

In this extract the teacher does not use funnelling to get the pupil to give the correct answer, but improvises with the answer given, reworking this into a correct formation, an act which the pupils seemed oblivious to. This then serves to reproduce the correctness aspect of high-ability identity, allowing the pupil to maintain their position.

10.2.2 Reproductive practices

Practices within, or related to, the primary mathematics classroom help to reproduce a high-ability identity. I have previously discussed the differential set teaching practices where, reflecting the US literature, teachers as well as pupils are 'tracked' (Finley, 1984) with more experienced and more motivated teachers often being assigned to top or high-stakes sets (Kelly, 2004, 2009). Pupils are aware of the differences, noting greater curricular access for pupils in these sets:

> Rachel: So what's good about the maths groups?
>
> Thomas: If you're in the top one you can learn more.
>
> (Avenue, Y4, S1, 07.02.08, Lines 39-40)

Thomas talks about being able to learn more through his placement in the top-set. Within top-set lessons and when interacting with higher-ability labelled pupils, there is evidence of teachers holding higher expectations in terms of the work they set, although conceptions of what makes mathematics harder may be erroneous here. Pupils are aware of these differences, the taken-as-shared meanings behind this and the relation to ability-groups:

> "Being top-table you get to like do, you get to do harder stuff than the other children like when we do this sheet they all have to start on part A but we get to start on B because we already know how to do A."
>
> (Abbie, Parkview, Y6, S1, HA, 27.11.07, Lines 32-35)

Actions such as this, which were common for higher-ability groups, resulted in reproduction of a high-ability identity. High-ability was conflated with getting more done – because more is available – and being more mathematical – because they have access to tasks that appear more mathematical – hence the practices associated with high-ability labelling serve to reproduce high-ability productions.

Approaching mathematics with ease and working quickly were produced by pupils as signs of high-ability. Pupils were aided in enacting these behaviours and hence such productions were reproduced, by the methods of mathematics teaching used by most teachers. Much teaching, as in secondary mathematics classrooms (e.g. Boaler, 2000b) took the form of procedural learning in which pupils were required to copy, memorise and apply a set of methods. Pupils who did this, without requiring understanding, were seen as working with ease and hence produced as high-ability. Those who questioned why something was done, who sought understanding, or adapted methods, were more likely to be labelled as displaying a low-ability identity. Procedural learning and the memorisation of facts and methods was particularly strong in Set 1 lessons at Avenue where methods were demonstrated for pupils to copy and practice. The application of methods appeared to be an aspect of what counted as mathematics, as this extract from a lesson where the teacher and pupils both turned to the use of a standard algorithm suggests:

> Many of the questions, despite being mental maths, are approached from the perspective of standard algorithms, even if this wouldn't be how they were done in real life: The question reads £100 - £17.47. The teacher gets the pupils to partition £17.47 into £17, 40p and 7p. Each part is then taken away. The same is repeated for 1000 - 989. Rather than using intuition/thought, pupils are directed to go straight to a standard algorithm.
>
> (Avenue, Y4, S1, 06.02.08)

It appeared that to do well and be considered correct, pupils had to put aside real life, instead working in a procedural manner without questioning. Many pupils, when I questioned them about the work they were doing, were unable to identify mistakes in the procedural application or to think about why they were doing something beyond saying "that's what Miss Barton said to do" (Parkview, Y6, S1, 14.11.07). However, these pupils were thought of as high-ability by their peers for they enacted a high-ability production of ease enabled by the practices of the mathematics classroom, and particularly prevalent in top-sets.

Assessment, as discussed in the literature review, is strongly tied to notions of ability, and hence implicated in many reproductive processes. Assessment is so pervasive in schools that it has come to be integrated into and define everything about schooling, about the pupil as an individual and about their place among their peers (Hall, et al., 2004), with many commentators (Hall, et al., 2004; Hamilton, 2002; Pollard, Triggs, Broadfoot, McNess, & Osborn, 2000) arguing that assessment processes are central to the production of pupils' identities.

Assessment allowed the simplistic categorisation of pupils, reproducing ideas of pupil difference and naturalising labelling. It also impacted directly on teachers' practices with teachers placing a high degree of trust in assessment outcomes and hence altering practices in relation to summative results, even where these conflict with teacher assessment:

> "Yeah, that does happen quite a bit, because last time we did practice SATs, before I got a 4A and then Miss Gundry kept asking me, do you want an easy sheet, is this too hard, and then I got 5A I think and she was, I think this is too easy for you and she kept giving me really hard work and I was really sad. She does think you can do well if you get higher marks."
>
> (Olivia, Avenue, Y6, S1, 03.06.08, Lines 108-112)

Here Olivia was talking about how the mock tests impacted on teacher practices. Olivia felt that the outcome of these tests was the sole consideration in the teacher's differentiation of subsequent tasks. The teacher's classroom differentiation based on assessment levels added to pupils thinking of themselves and others in terms of levels and reproduced ideas of pupil difference.

This section has suggested how many common practices of the primary mathematics classroom have the potential to reproduce productions of ability, particularly high-ability.

In conjunction with teacher-pupil co-construction, these exert a powerful force on pupils' productions, sustaining ideas related to high-ability and allowing ability productions to continue.

10.3 Embedding a Low-Ability Identity

Pupils' productions of low-ability were examined in section 7.3.2. As with the above section related to high-ability performance, I now look at how pupils perform a low-ability identity. The axial-coding suggested two areas as the major constituents of performing a low-ability identity – poor classroom behaviours and poor learning behaviours – which sit in opposition to performing a high-ability identity. This section considers how pupils perform a low-ability identity, or how their actions are reinterpreted as being representative of a low-ability identity and hence how low-ability is reproduced, by teacher co-construction and classroom practices. Within this section I also consider the role of teacher reproduction, that is, teachers reproducing practices and experiences from when they were pupils, and how this may reproduce and embed the acceptance of low-ability behaviour and positioning.

10.3.1 Teacher and pupil co-construction

Whilst for high-ability co-construction teachers worked *for* pupils, low-ability co-construction was often a process carried out *against* pupils, although it is important to stress that this was not usually deliberate or carried out for negative reasons. In fitting with behaviourally driven productions of low-ability, co-constructions were also focussed on behaviours rather than mathematics.

Aspects of low-ability identity co-construction suggested how nuanced the processes could be. For instance, verbal engagement is taken as indicative of high-ability, yet if this occurs at the wrong time it is taken as indicative of low-ability. The difficulty for high-ability pupils and their teachers occurs when pupils engage in such behaviour at the wrong times. Lesson observations suggested that *all* pupils engaged in behaviours such as talking at inappropriate times. However, differences occurred in how teachers responded to these. For instance, if the whole class were engaged in low-level talking whilst working, when asked for quiet it appeared that greater leeway was, on occasion, given to pupils labelled as high-ability. Behavioural reprimands seemed to be given more quickly to pupils expected to engage in poor behaviours. These different responses did not go unnoticed by pupils:

> "Kayden and Ethan always sit together and they never get told off, I don't know why because they are always talking but Mr Leverton does never realise it, because, I don't know, I think he looks and sees and then ignores them, but when me, us three are sitting next to each other, he doesn't ignore then, he says, oh move move move."
>
> (Sam, Avenue, Y6, S4, LA, 21.11.07, Lines 21-25)

In this extract, Sam talks about the different reactions of the teacher to the same behaviour exhibited by different pupils. Kayden and Ethan were thought of as higher-achieving pupils and it appeared to be the case in observations, as Sam alludes to, that they were treated differently, being allowed to work together when pupils had been told to work individually and being allowed to talk when the teacher had asked for silence. Sam refers to the teacher seeing but ignoring the behaviour, suggesting active co-constructed identity work rather than the teacher being involved in something else and missing this behaviour. The contrast with the response to Sam, labelled as low-ability, adds to this, drawing attention to behaviours that are ostensibly ignored in other pupils.

This process and associated identity co-construction of *not* drawing attention to particular behaviours was exemplified within the pilot to this study in the example of two high-ability labelled boys engaging in off-task castle-building with their cubes having completed their mathematical activity (see Hodgen & Marks, 2009, p. 36), a behaviour at odds with their established identity. I was vividly reminded of this incident during an observation within the present study involving the same mathematical apparatus and similar behaviours:

> Zackary is working on the question 57 + 32 = He has set this out vertically (the lesson is looking at the vertical addition algorithm). The pupils are expected to use cubes to support them with each stage of the addition, but Zackary seems confident that he knows 7 + 2 and 5 + 3 (as they were taught by the teacher) without the need for cubes and so he works through the questions fairly quickly, and apparently more quickly than expected by the teacher. When he tells the teacher he has finished he is asked to check each one with the cubes. Zackary does not appear too happy with this response, does not check his answers by any means but instead uses his cubes to build a light-sabre which he uses to silently 'attack' (without physical contact) a pupil sitting across the classroom. The teacher notices this behaviour and instantly chastises him, saying "that is not what we use the cubes for" and telling him that he needs to get on with his maths.
>
> (Avenue, Year 4, Set 4, 30.01.08)

Unlike the teacher's response to the castle building which could be categorised as similar to the "ignoring" Sam spoke about, the teacher in this extract draws attention to the incident with the behaviour fitting the pre-constructed pupil identity. It is possible the teacher's knowledge and behaviourist image of learning mathematics contribute towards this incident and the reproduction occurring, for the teacher lacks any alternative way of teaching and responding. Of course these involve different teachers and different contexts so a direct comparison cannot be made, but they add to evidence that teachers appear to be acting in a process of identity co-construction with pupils, and reproducing understandings of ability.

Further differential treatment was seen in the mathematical opportunities open to different pupils and how teachers interpreted similar mathematical and learning behaviours in different pupils. For instance teachers talked about high-ability pupils as able to explore and use their own methods to solve problems, interpreting this in terms of creativity and originality:

> "George is a very confident mathematician, he's confident in showing what he can do, he loves the challenge of particular activities, you know problem solving, he really loves to attack those problems if you like, he's, you know, whatever I throw at him, he'll manage to work it out or find his own way to do it as well which is good."
>
> (Mr Donaldson, Parkview, Y4, Class 1, 21.07.08, Lines 61-64)

Mr Donaldson talks about George finding his own way to solve mathematical problems in positive terms, talking about confidence, challenge, and a love of such work. There are no negative overtones to his assessment of George's approach. George, as was observed in class, is given the opportunity to further develop his own understanding secure in the knowledge that such learning behaviours are taken as not just acceptable, but adding to his identity as a high-achieving pupil. George's experiences, and Mr Donaldson's interpretation of them, sit in contrast with Zackary's experiences:

> "Yeah, he will always take that risk and have a go providing he can do it in his way, he won't always do it the way I'm hoping, you know, he won't always do the method we're looking at, but he will just go for it, whereas these two will always try to follow the method properly or they'll have a go at the method even if they're not really clear and if it doesn't fall into place they will come to a dead stop and that will be it then and they will ask for help, which is fine, but he will sort of, abandon that method and do it his way or even perhaps start on his way regardless and not even bother with the right method."
>
> (Mrs Jerrett, Avenue, Y4, S4, 16.07.08, Lines 33-40)

Mrs Jerrett talked about similar behaviours to George's, but with a different, less positive, interpretation. Whilst she talks about Zackary taking a risk which may be seen as positive and about confidence in the same way Mr Donaldson talked about George, she quickly moves on to interpreting his use of his own methods in terms of not doing what he should be doing, contrasting him with two other pupils who "follow the method properly". She goes on to say that the other pupils stop and ask for help if they are unable to follow the method, clearly the behaviour she wants the pupils to demonstrate, but then speaks about Zackary in more negative terms talking about him not bothering with the right method. Evidence of this was seen in lesson observations where Zackary would employ his own, often appropriate, methods but, unlike George who was encouraged in such pursuits, was often stopped and redirected back to the 'right' method. This was despite his often quite vocal protests which were interpreted for other pupils as poor classroom behaviours, potentially serving to reproduce pupils' understandings of what low-ability meant.

Although pupils talk about teachers' actions as if they are malicious premeditated behaviours, it seems unlikely that teachers are aware of the differential treatments they enact or of how pupils are interpreting these actions which the teachers may see as supportive. Multiple observations of Mrs Jerrett's lessons suggested that she was acting in a way to support, guide and care for the pupils. Indeed, further in her interview she talked about "trying to boost confidence" (Line 80), with methods for this involving protecting the pupils from challenge and struggle, using smaller numbers and plenty of repetition, and often leaving topics that appeared too difficult for "fear of them all sort of panicking and freaking out" (Lines 268-269). At times this resulted in tensions between pupils and herself as these three extracts from different stages of a lesson observation show, yet her intention was, as she discussed with me, to support and protect the pupils:

> Mrs Jerrett explains that they will be re-using and extending the work they have started on column addition. Zackary asks if they can do them with thousands and Kyle asks excitedly if they can do millions. The teacher replies that they can't because she doesn't want them to rush on and make mistakes.
>
> … The pupils are working through the addition method on the board. The teacher uses extensive funnelling to prompt Zackary to say 80 but having given the teacher what she wants to hear he adds to it, very tersely, that he wants to do questions with millions. The teacher replies "Can we please not fuss about millions and thousands because we are not going to be doing them; we are doing tens and units which we can do and need to be doing".

> … Later, in talking through the method a second time, the teacher asks the pupils if they can remember what "the line" is for. I am unclear what answer she is expecting. She chooses Zackary (he doesn't have his hand up) and asks him if he knows what the line is. Quite angrily, and through gritted teeth, Zackary answers, "no, because when we did it yesterday, Mrs Smith gave me one in the thousands to work through."
>
> (Avenue, Y4, S4, 30.01.08)

Within this lesson the pupils were extending addition work they had previously started with a supply teacher, Mrs Smith. Talking to Zackary and looking at his earlier work, it appeared that the supply teacher had allowed him to extend his work using bigger numbers. As with many pupils, Zackary seemed to associate big numbers with more difficult mathematics and was keen to continue with this work. However, Mrs Jerrett saw it as appropriate only to use smaller numbers with these pupils, leading to a conflict between herself and Zackary, for which Zackary was reprimanded. These actions may have intensified, not just for Zackary but for others in the class, the 'correct' low-ability identity they should be holding and enacting, which in this case involved only working with small numbers.

Mrs Jerrett's approach, and that of other teachers, also co-constructive and reproductive of low-ability identities, was not enacted with a reproductive intention, but because they did not have alternative methods of working. One reason for this, particularly where the weakest teachers are assigned to bottom-sets, is that teachers themselves are also part of the reproductive process, not just reproducing societal conceptions, but also reproducing their prior experiences as pupils and as such the negative productions of ability that are part of these. This reproductive process was discussed in some depth in Hodgen & Marks (2009) and hence is not reiterated here other than to note that the same historiographical reproduction discussed there was also found in the present study, although this was not a focus of the research.

10.3.2 Reproductive practices

As with the reproduction of high-ability identities, there are many primary mathematics classroom practices which work to reproduce low-ability identities. Some of these are the same as for high-ability, as they reproduce more general productions of ability, such as the role of assessment in strengthening ideas about individual difference and naturalising categorisation. Further, as discussed previously, teachers treat sets differently, responding with their assumptions to pupil labels and so enacting a self-fulfilling prophecy in terms of expectations, which also reproduces low-ability identities in terms of what is, or is not, expected of pupils.

Extending these differential practices, one key area in which a practice was seen to reproduce low-ability identities was the process of educational triage. Quantitative evidence for this was highlighted in section 6.2.2. At Avenue, reflecting the literature on educational triage discussed in section 3.4.1, pupils in Year 6 who were expected, with additional input, to achieve a Level 4 in their SATs, were triaged into Set 3, alternatively referred to as the Cusp group, whilst pupils deemed unable to achieve a Level 4 even with additional support were placed in the bottom group, Set 4. The Cusp group received an enriched curriculum and 'better' teachers, something staff at Avenue were quite open about:

> "Usually we put the strongest teacher in the Cusp-group or in the most able group, they're the main two"
>
> (Mr Iverson, Avenue, Y4, S1, 16.07.08, Lines 132-133)

At the same time, the teaching of the bottom-set was shared on alternate days between a floating supply teacher and an HLTA; this set did not receive any teaching from a permanent member of staff. Mr Leverton discussed this practice in his interview, which is particularly revealing given he was directly involved with it in his teaching at Avenue:

> "I mean depending on the teachers that you have, if you've got a good range of teachers and you give your top-set to a teacher who's really very good at it, then you are going to get a difference, but it depends on how you, sometimes the bottom-set is often given to someone who has just come in I imagine, in some schools the bottom-set has a Higher Level Teaching Assistant taking them which I think is atrocious, I mean there, it's like if you've got dyslexia and you are given a Teaching Assistant to work with you but if you took it as a medical thing then you've got pneumonia and you're given a non-specialist nurse to look after you. If you've got something seriously wrong with you then you need a complete specialist to look after you, that's why if you have got dyslexia you should have an expert to look after you and not someone who is making it up and using games."
>
> (Mr Leverton, Avenue, Y6, S4, 16.07.08, Lines 238-249)

Again, as with Mr Iverson's extract, Mr Leverton refers to the tracking of teachers. He discusses the need for bottom-set pupils to have specialist teachers, relating this to the use of specialists in other fields. Mr Leverton's concern about TAs being responsible for pupils with high levels of need yet being non-specialised and not having time to prepare for this role is born out in the literature (Webster, et al., 2011). It appears that teachers with some mathematics specialism are allocated to the top sets or Cusp-groups, substantially reducing the opportunities for pupils in the bottom sets to develop any level of meaningful engagement with the subject, and potentially reproducing their non-mathematical low-ability identities. These practices reflect the US literature which suggests that 'teacher tracking exacerbates the inequalities in opportunity to learn produced by tracking by matching the teachers who are most likely to be successful in the classroom with the students who already occupy a privileged position in the educational system.' (Kelly, 2009, p. 454) In effect, some pupils are doubly disadvantaged both as a result of their differentiated grouping practices and the tracking of their teachers. The impacts of this for Set 4 pupils were seen in the quantitative data presented in section 6.2.2, highlighting the widening attainment gap between Sets 3 and 4. The practice of educational triage reproduced low-ability productions by drawing attention to the low expectations of Set 4 pupils and distancing them from other pupils as incapable of higher achievement, also reproducing ability as innate and individually limited.

10.4 The Implications of Reproduction

In this chapter I have examined how discourses of ability may be reproduced in the primary mathematics classroom. This process has been looked at in terms of pupil and teacher co-construction and the reproductive potential of common primary mathematics classroom practices. In addition to reproducing and sustaining discourses of ability, the co-constructive and reproductive practices discussed in this chapter also have further implications for pupils, particularly in terms of their mathematical identity development, which in itself may be seen as part of the reproductive processes occurring.

Teachers' reproductive practices and hence pupils' developing understandings and responses became cyclical, strengthening each other and making reproductive practices difficult to break. This was seen for example in a Year 4, Set 1 lesson at Avenue in which the teacher's practices reproduced a high-ability identity of fast-paced working:

> As the pupils are working, the teacher needs more room on his board. He tells the pupils that he is rubbing the first one off the board as they should have copied it by now, or else they shouldn't be in that set.
>
> (Avenue, Y4, S1, 06.02.08)

In this observation, pupils were being taught a traditional subtraction algorithm, watching the teacher demonstrate the procedure and copying multiple examples into their books. The teacher's intention, as he explained to me prior to the lesson, was that through repetition the pupils would come to understand the method, although understand seemed to mean application. Pupils were not required to engage with the mathematics, with some copying what was written on the board, *in any order*, to produce the end result as quickly as possible. Although the teacher had intended pupils to learn the process through copying, the value placed on speed and intensified through comments such as that in the extract above, led pupils away from the procedure being taught to engage in practices suggestive of a high-ability identity, in this case, finding the quickest way of getting the work copied down. By working in these ways, pupils were limiting their mathematical engagement and potential for understanding. However, by finishing the copying task quickly, they were intensifying the conjoining of high-ability with speed, potentially leading to the teacher enacting similar practices in future. This process benefits neither the teacher nor the pupils mathematically, yet manages to reproduce a high-ability identity absent of any mathematical involvement.

The above example suggests how reproductive processes restrict access to more mathematical ways of working for high-ability pupils. This restriction in the development of a mathematical identity was also a concern for low-ability labelled pupils as a result of practices they encountered. As discussed in Chapter 8, low-ability pupils were often given less access to ways of working such as the use of derived facts and as a result actually had to do 'harder' mathematics than pupils taught to work in more economical ways. The result was that for these pupils, mathematical access was restricted.

Access was also restricted for low-ability pupils as a result of having less confident or experienced teachers in the bottom sets. These teachers found it harder to engage with interesting ideas brought up by pupils, to follow-up tangents to the planned lesson or to explore ideas mathematically. In holding a view of mathematics as right or wrong, discussion was limited, which may have underpinned some of the missed opportunities for mathematical engagement, and hence the possibility of developing a stronger mathematical identity in some bottom-set lessons, as in this observation:

> The teacher then moves on to talk through the names for 2D shapes. There are lots of interesting shapes on the board but many of the names are not used as pupils are only grouping them by number of sides. The teacher talks through ways to help the pupils remember the number of

> sides each group has. She talks about the need to make connections, for instance hexagon and six both have an x in them so hexagons have six sides.
>
> (Avenue, Y4, S4, 20.11.07)

Within this lesson, pupils were initially seen to be quite engaged with the subject matter, but this engagement waned considerably through the course of the lesson as pupils repeated the same task multiple times and interesting points they raised, such as the existence of a 'left-angle' or asking whether a square was a rectangle, were ignored or reprimanded. The teacher's awareness of the importance of making connections initially seemed positive, but in all cases these were not to other areas of mathematics. These relied on the application of non-mathematical skills – such as spelling – which many of these pupils also struggled with, strengthening the pupils' general productions of themselves as weak learners and restricting access to mathematical engagement and identities. In some lessons, pupils demonstrated an awareness of the restrictive processes occurring and challenged these actions in an attempt to engage with what they saw as "harder maths". This was seen in the case of Zackary in section 10.3.1 who wanted to use larger numbers and refused to work with cubes and also occurs with Benjie below:

> Teacher: [Finishing previous question] Okay, 17 boys are left. Now, $\frac{1}{2}$ of the pupils go to another classroom. How many pupils is that?
>
> Benjie: So, from the answer, $\frac{1}{2}$ go ….
>
> Teacher: No, no, that makes it too complicated for you. $\frac{1}{2}$ from the class of 28.
>
> Benjie: It's 14, but from the …
>
> Teacher: Ah no, next, today out of the class of 28, $\frac{1}{6}$ are off sick. Oh, no, no, no, we'll make that $\frac{1}{7}$ are off sick. I prefer classes of 30.
>
> Benjie: [Following a highly exaggerated sigh, aloud to the teacher/class] Can you give me some hard questions?
>
> (Avenue, Y6, S4, 05.03.08)

In this extract, Benjie attempts to engage with harder mathematics than that intended by the teacher. Rather than allow Benjie to think about this or engage in a discussion about the mathematics involved in finding ½ of 17 and relating the answer to real life given the question involved 17 pupils, the teacher rewords the question with the explanation that trying to find ½ of 17 would be too complicated for him. This is likely to have implications for reproducing the productions of mathematical-ability developed by these pupils in addition to severely restricting their access to mathematical concepts. Benjie appears to be quite persistent within this extract. Having given the correct answer sought by the teacher, he then tried to re-engage with the question as originally interpreted, but was quickly stopped by the teacher who went on to simplify the next question. Benjie's reaction to this appeared to be one of exasperation and awareness that he was being limited in terms of the mathematics he had access to. The incident in this extract is not unusual but reflective of bottom-set lessons observed whereby pupils faced barriers put in place by the teachers' unintended actions in accessing more mathematical concepts. It becomes clear, when repeated on a daily basis throughout the pupils' primary school careers, how such actions may result in, among other things, a widening attainment gap and a lack of mathematical engagement.

In concordance with the time involvement in non-mathematical identity work discussed in Section 9.3 the examples discussed in this chapter suggest that quite substantial amounts of both pupils' and teachers' time are taken up with the processes of ability reproduction, whether this be through intentionally improvised acts or through practices and interactions that have become everyday as a result of the dominance of ability. The incidences suggest that pupils are engaged in a delicate balancing act with extensive time dedicated to identity work; identities that in the most part are not mathematical but are produced and reproduced as such.

The discussion in this chapter suggests how difficult change is, for sources of reproduction of discourses of ability are multiple, adding to views of such discourses as natural as they are an ongoing feature of daily life, not just within schools, but beyond them. The problems associated with the continual reproduction of ability have been discussed and this chapter has contributed an understanding of why such productions continue in spite of evidence against ability predicated practices. This does not mean that change is impossible, but it does suggest that it will be difficult and will require significant consideration of these reproductive relationships and many people working together with the same common goal of change in order to break the long-term cycle of the reproduction of discourses of ability currently seen. The following chapter – looking at the transformation of ability – begins to engage with the concept of change, considering where ability practices are challenged and why change may be difficult.

11 Transforming the Pervasive use of Ability in Primary School Mathematics

11.1 Introduction

In the previous chapters I have examined how pupils and teachers produce discourses of ability, how these are enacted and how, through co-construction and the practices of the primary mathematics classroom, they may be reproduced. In this chapter I consider the third aspect of my overarching research question: transformation. The previous chapters have suggested the need for change in highlighting the negative impacts for all learners of a pervasive discourse of ability. These previous chapters suggest that change is necessary but also that it is potentially difficult. Many of the consequences of working within a pervasive discourse of ability are unintended or go unnoticed hence the need for change may not be realised or the barriers to change may be considered too great.

I begin the chapter by looking at pupils' and teachers' engagement with ability. I look at their awareness of the impacts, why they may engage with it as they do and any incidences where they talk about ways of doing things differently. I then look in more depth at why transformation is important yet so difficult, before examining alternative models proposed in the literature. This leads into a discussion in the final chapter considering the possibilities for change and how the current dominance of ability could be transformed.

11.2 Noticing and Challenging an Ability Ideology

Practices associated with ability have a long history in primary mathematics and appear to be caught within a reproductive cycle. Where changes occur these are often temporary as they try to fit within a system built on an ideology of ability. The strong ideology of ability in the UK creates particular difficulties with respect to change. As White (2006) argues (see Chapter 3), society is unable to see the everyday use of intelligence as in any way peculiar. This extends to schools where the use of ability goes unchallenged as it is seen as normal, reflecting social discourse and reproducing a familiar structure for education. Further, practices related to ability may remain unchallenged as they simply are not noticed, in the same ways the everyday use of intelligence goes unnoticed, resulting in such practices being 'taken-for-granted' (McGregor, 2004, p. 13).

The data in this thesis support the assertion of practices being unnoticed. This was particularly true with the consequential practices discussed in Chapter 9. However, there was not a complete lack of awareness. At times, particularly where something negatively impacted on an individual, pupils did talk about how practices, which could be said to be predicated by ability, worked against them or others and appeared unfair. Further, teachers raised concerns about particular practices and showed some awareness of the literature on ability-grouping. However, this was often followed up with reference to intuitive beliefs and social understandings which seemed to take precedence over the literature they were aware of or their concerns about practices they were engaged in. An acceptance of everyday understandings and a belief that teachers could not bring about change appeared to reduce teachers' willingness to engage with what was happening or to think about change.

11.2.1 Equity and fairness: Pupils' engagement with ability and its practices

In this section I look at pupils' awareness of the extent to which ability impacts on their mathematics experience. Perhaps unsurprisingly given the role of assessment in producing and reproducing notions of ability, assessment was central to pupils' discussions of fairness. The teachers within this study talked about the pressures of an unfair and unjust external examination system, particularly in relation to SATs. This was expected with testing being part of teacher discourse. Less expected were pupils' affective responses to assessment. As discussed in Chapter 8, Year 6 mathematics lessons at both schools were dominated by SATs and revision. Pupils conflated mathematics and SATs, with SATS and revision being taken as a large aspect of what mathematics is. This may provide qualitative data to help in understanding the complex quantitative associations noted in relation to Competitive beliefs. Across the study, pupils spoke about enjoyment in terms of new experiences and learning new things. They appeared to value the opportunity to increase their mathematical knowledge and understanding, something less likely to occur where the focus is on revision. This assessment focus also had a more profound impact, affecting pupils' understanding of the very nature of mathematics and what it meant to do well in mathematics:

> Natalie: Doing well in maths tests, because that's quite important because that's what you get sent off to your sets

> Olivia: That's what all that is combined, so it's one of the most important things
>
> Megan: That's what doing well in maths is
>
> (Avenue, Y6, S1, 03.06.08, Lines 70-73)

Megan highlights a common belief amongst the pupils that they are judged in mathematics solely by test results. They may not be incorrect with many teachers talking about the use of tests to assign pupils to groups, despite some teachers feeling the tests did not always give an accurate representation of what pupils could do. The strength of assessment structures was revealed in pupils' fears about the implications of not doing well. Like Hannah, who would 'be a nothing' in Reay and Wiliam's (1999) study, pupils in the present study saw assessment results as implicated in their future lives:

> Rachel: And what happens if you don't do well in your tests?
>
> Peter: Well you won't get a good job … These SATs are going to your next school and it won't give a good impression.
>
> (Avenue, Y6, S4, 04.06.08, Lines 28-32)

Understanding how pupils such as Peter understand assessment structures is important. The quantitative data in this study revealed pupils to be very aware of their attainment levels with a significant correlation between attainment and perceived ability (see discussion in Chapter 6). This awareness is likely to impact on how these pupils see their future. Pupils' awareness extended to the language used suggesting a reproduction of teachers' discourse:

> "When we have maths SATs I don't really like them, I don't really like SATs … And I don't like tests like the CATs tests, because they are really hard sums like 100 – 89 or something like that."
>
> (Zackary, Avenue, Y4, S4, LA, 20.11.07, Lines 91-97)

Zackary showed a strong alignment with the assessment vocabulary of SATs and CATs, highlighting the proliferation of such language within primary mathematics. Pupils appear dissatisfied with current practice as highlighted by the Year 6 comments about the focus on revision. The majority of pupils are profoundly affected by the implications of the assessment structures, knowing their placement and being acutely aware of, and in some cases experiencing anxiety because of, their understanding of the implications of these assessments. Teachers share many of these concerns, hence this would appear to be a key area for the possibility of transformative action.

One area pupils brought up us a source of consternation was the perceived differences in teachers' responses to differently labelled pupils. In the following two interview segments from an individual and group-interview with Natalie, she explains her perception that practices based on deterministic beliefs can be detrimental to all pupils including higher achievers:

> "She always comes round and says like, to the people who aren't so confident, she comes round and sees how you are doing but she doesn't do that to the clever people."
>
> (Natalie, Avenue, Y6, S1, MA, 04.03.08, Lines 75-77)

> Olivia: And it's like, I used to sit next to Bill, and we had this homework and we got it handed back and it was 20 questions and I got 14 right and I got a quality mark and Bill got like one wrong and he didn't get anything and I thought that was really strange.
>
> Megan: Yeah that's the same with…
>
> Natalie: Yeah, if someone really improves, like if someone usually gets 7 in a mental test and then they get 17, then that would be a really big improvement so if it was done on quality marks they would probably get three or something, but if someone had just, one of the brighter kids had got like 18 last time and now 19 which is really good or 20 or something they would still only get one, which is quite unfair sometimes.
>
> Megan: Like, here's an example, a friend Rebecca, on a homework, she got two wrong but she got a quality work and I did the same piece of work and I didn't get a quality mark because the teacher will expect you to get this much right because she knows or he knows that you can do this well.
>
> Natalie: Because if you go down, even if you've done really well, so if you had 20 and then you get 18, you wouldn't get anything even though you have still done well, which is quite upsetting for the task as you have still tried your hardest.
>
> Olivia: It must be really frustrating if you got every single one right and you get nothing for it and someone else got two and they got a quality mark, it would be really frustrating.
>
> (Avenue, Y6, S1, 29.04.08, Lines 130-149)

Natalie's discussion exemplifies how, under deterministic beliefs, the teacher's practices may be based on perceived difference rather than giving all pupils the same opportunities. Within the group-interview, the pupils were discussing a ceiling effect and the limited possibilities for them to demonstrate achievement, something they see as frustrating. This interview segment suggests the need, when considering reform, to look at the experiences of all pupils. Suggestions of reforms to ability-grouping systems are often discussed in terms of supporting lower attainers and if anything there is a concern that removing practices such as ability-grouping may be detrimental to top-set pupils and high-achievers. Here we see how the labels and practices also have a significant impact on those pupils expected to benefit from them. The difficulty for pupils in showing improvement also came up in their discussion of teacher questioning where pupils showed awareness that the questions or questioning strategies were overtly differentiated for different pupils:

> "That's why the teacher doesn't, never, picks on Victoria. It's always Thomas? Thomas? Thomas? Thomas? And she might think, oh the teacher's never going to pick me, there's no point in saying what I want to say, but she never just gets a chance. Even when Thomas ends up getting the questions wrong, the teacher's like, oh I like Thomas the best, so I keep asking him, and I hate Victoria, so cross, cross, cross, cross."
>
> (Uma, Avenue, Y4, S1, 07.02.08, Lines 204-209)

> "The teachers would pick them for every question, every hard question and go to the not so good people for the easy questions. If it was the person down here, the teacher would never ask them any questions because they know that they would be silly and everything when they answer them, and so the teacher won't involve them in lessons. They could get better, but no one would know because the teacher wouldn't pick them, it would be very difficult for them to show they were better."
>
> (Peter, Avenue, Y6, S4, HA, 21.11.07, Lines 70-75)

Whilst Peter talks about questions being differentiated to perceived ability, Uma discusses the limited opportunities for participation of some pupils as a result of teacher practices. Both issues were seen regularly in classroom observations. These pupils talk quite fervently about these concerns, challenging current practice and being aware of the consequences, not just in a self-interested way but in terms of the consequences for peers as well. They suggest the need for change to structured practices and, particularly in Peter's quote, problematize practices that teachers may be using in a genuine attempt to be supportive to pupils. In such circumstances, understanding where pupils see the need for change is vital as the same practices are being understood very differently by teachers.

The pupils' concern about other pupils and equitable practices came through strongly on many occasions. An issue that repeatedly arose was the process of assigning pupils to sets and the lack of movement within these. Sam talked about these limited opportunities:

> "And it makes me annoyed and sad and upset because I wanted to be top of the maths group, I always wanted to be when I was first into this school, but my wish didn't come true, I've always been last in every maths group, I don't really know why, but, I think in year 5 I had a chance to go up a group but then I just went low low low and then I just didn't go. I'll just be low now in my next school too. … Well I wanted to move, I wanted to move up, I wanted to move to up there, but I'm always there. I can't move even when I want to … the teachers say I can't do the test and my friends think I'm dumb for not being allowed to do the test. That's how it works, I won't do the test, it makes me unhappy and I can't get better to get the tests to go up.
>
> (Sam, Avenue, Y6, S4, LA, 21.11.07, Lines 48-53, 87-88, 101-103)

Sam appears not to have accepted his position because he believes it to be a true reflection of his achievement but because, despite trying to fight against the ability structures, he has been unable to move due in part to the practices surrounding his deterministic placement. He is clear that he has wanted change but has been unable to bring this about, identifying the teachers and their actions, which they may think of as protective, as a barrier to his development. This suggests that for transformation to occur there needs to be a willingness to change amongst all involved. There is also a need to be able to openly question and discuss practices and for practices that have become embedded into daily routine to be brought to the fore.

11.2.2 Teachers' awareness of the pervasive nature of ability

The teacher interviews gave teachers space to think about issues surrounding the practices they engaged in:

> Rachel: I haven't got any more questions, thank you for talking to me, I've left you with some things to think about.
>
> Miss Barton: Yeah I know, it's freaked me out now, that was interesting though.
>
> (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 367-369)

Overall, the teachers were positive about this experience but their reactions demonstrated that spaces to discuss school structures and pedagogic issues were usually absent in their daily lives as teachers. Miss Barton talked about being "freaked out" not negatively, but in terms of the number of times she brought up practices that, on reflection, she had been unable to justify, for instance the use of setting in mathematics but not in literacy. After this interview, I joined Miss Barton in the staffroom where she proceeded to engage other staff in a discussion regarding the issues we had raised; what ensued was quite a lively discussion amongst four staff members which to me suggested that it is not necessarily the case that staff engage in practices because they believe them to be entirely correct but because there is simply no space or provoking material within the confines of their teaching role to facilitate such discussion. Without such a catalyst to change, it is perhaps clearer why there appears to be a high degree of reproduction, even where these practices are felt to be iniquitous.

This lack of space to consider the implications, in particular the unintended consequences, of ability predicated practices seems particularly important in cases where teachers believe they are acting in the best interests of the pupils. For instance, as discussed within many issues in this thesis, teachers often believed they were acting in a caring and protective manner, a position central to teaching (Noddings, 2003). The core practices involved in this 'care' resulted in limiting the mathematical experiences of lower-attaining pupils. By using smaller numbers, limited methods and requiring the use of manipulatives, teachers felt they were supporting their pupils and acting against mathematics being experienced as a frightening subject. However, pupils viewed these limitations differently, often exhibiting frustration. Further, there were cases where low-attaining pupils, often those with SEN, colluded with teachers, albeit without awareness of doing so, in order to project a 'helpless' identity which teachers responded to in ensuring they were only giving work in which they would experience success, and hence never moving beyond their current level of attainment. This finding is supported by the literature (Youell, 2006) with teachers not wanted to act in ways which may be deemed cruel, and suggests the need to challenge, with teachers, the notion of care.

An aspect of the teacher interviews I found difficult was that, and in contrast to my expectations, a number of teachers showed an awareness of the research evidence on ability-grouping, yet they continued to enact these practices. This awareness is highlighted in the following extracts from three teacher interviews:

> "I think studies have shown that it [ability-grouping] doesn't make a lot of difference, but people believe in it because people think it is a logical thing … In maths they don't do that [mixed-ability teaching], and that's very very important because you don't get the effect of the kids who know dragging up the kids who don't know, because if you're in a successful class, if you're in a class that succeeds, in a class that had positive vibes about it, that will affect everyone, but if you are in a group which does not have positive vibes, then you haven't got it."
>
> (Mr Leverton, Avenue, Y6, S4, 16.07.08, Lines 230-232, 260-264)

> "I also believe that if you stream children in maths, in other words you split them top, middle and bottom, the top-group is fine but every other child suffers and they won't have the same opportunities to improve as the top-group do. Top-group lovely but it's these middle bands that need to be in a group, well you learn better from your peers as role models, the children around you, and if you're put in this group, you will think, I'm this at maths and you're never going to, it's difficult to aspire better and then the teaching and the learning, although it shouldn't be focussed where they're at, it's never really challenging whereas the teaching in the top-group is always challenging because of the energy in the room, so you need some of these children over here to bring the learning up."
>
> (Mr Iverson, Avenue, Y4, S1, 16.07.08, Lines 90-100)

> "Well, like mixed-ability I think is good for the children, it's good for them not to be labelled as lower-group, top-group, you know."
>
> (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 280-281)

All three extracts refer to an awareness of the problems associated with ability structures. However, these teachers were all engaged in using the practices they talked about as problematic. This is important as it suggests something about the pressures teachers are working under with personal beliefs and awareness not enough to bring about change. Simply supplying teachers with research evidence is unlikely to be a strong enough catalyst for change.

An issue several teachers referred to in discussing the problematic nature of ability-grouping was educational triage practices and the tracking of teachers. This was discussed previously in section 10.3.2. Teachers noted these practices as problematic but the forces bringing about these structures are powerful and multifaceted suggesting why change is so difficult. It is unlikely that schools are maliciously providing poor support for the lowest attainers but that the current ability predicated assessment system and external accountability makes such decisions appear necessary in many cases.

Pressures on teachers to ability-group have been long standing and may not be consciously realised as practices have become sedimented in teachers' actions. Mr Donaldson, who was the teacher freest from deterministic teaching practices, brought up this issue in talking about the difficulties of getting teachers to move from setting to mixed-ability teaching:

> "It [mixed-ability teaching] feels pressured, so there's more planning for it involved, more thinking about it, there's more adult support possibly that you have to really think about, whether what you're doing as well as another adult, it does make it a little bit more difficult and I think, the other thing is most are used to teaching sets as well, so breaking away from that is harder as well."
>
> (Mr Donaldson, Parkview, Y4, 21.07.08, Lines 200-204)

He recognises the pedagogic difficulties that may result if using mixed-ability teaching, but notes that there is an issue with teachers themselves who are used to one thing and that breaking away from this is difficult. This difficulty with breaking away is further evident in the previous interview segments highlighting teachers' awareness of the research. This adds to the difficulties with transformation: structural pressures and difficulty with change combine to make transformation difficult. What was particularly interesting at Parkview where Mr Donaldson taught was that setting was clearly a topic of some discussion even if teachers did not have extensive opportunities to consider it in depth. This contrasts with Avenue where decisions were made by the senior management team with regards setting practices and teachers were expected to abide by these. At Parkview there was always a degree of tension as to the best setting policy, to the extent that some practices fell under the radar of the head-teacher who was oblivious to the degree of ability-grouping being used. Whilst much of this chapter has been concerned with the pressures *on* teachers, they were also able to place pressure *on others* in order not to have to break away from present practices. Mr Donaldson highlights this in discussing the pressures placed by the Year 6 teachers on the head-teacher to ensure the continuation of setting:

> "The head-teacher came into this school and was very keen, she still argues at the beginning of every year with the year 6 teachers, do you really need to put them into sets, you know, she's not completely sure that they shouldn't but she feels that they shouldn't, the teachers generally persuade her, no we want them to be in sets still."
>
> (Mr Donaldson, Parkview, Y4, 21.07.08, Lines 212-216)

Although the teachers appear to have taken control, things are not quite that simple. Mr Donaldson talks about this being what the teachers want as if in joint agreement yet he later highlights the force the mathematics co-ordinator, one of the Year 6 teachers, has in this:

> "I taught year 6 for three years, it was before the present head was here and it was definitely in sets and the other year 6 teacher was very, the maths coordinator, she was keen on sets, she was keen on me having the top-group and her having the less able and really focusing on pushing them up, I mean focussing on the fours to fives."
>
> (Mr Donaldson, Parkview, Y4, 21.07.08, Lines 226-229)

Here he explains how one teacher, possibly through her position as mathematics coordinator, is able to influence the opinions of another teacher in order to obtain the desired outcome. It may not be, as Mr Donaldson first says, that "the teachers generally persuade her" but that one teacher has a powerful enough influence to enact a general persuasion. This would also fit with Miss Barton, the other Year 6 teacher, telling me in interview that she couldn't tell me much about how the pupils had been assigned to sets: "I'll be honest with you, Mrs Clifton [the mathematics co-ordinator] did it, I was there, but she literally did it" (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 263-264).

However, the picture is still more complicated. Whilst it would appear that the head-teacher rejects ability-grouping and is coming up against the teachers' wishes to continue this, she has also been noted as introducing a greater extent of setting:

> "Next year, Miss Attwood was talking about having three groups so even cutting it down even more, being even more specific, although I know that she's not so keen on setting for similar reasons, that it's nice to work mixed-ability that the, she thinks the less able children will aspire to the more able, but I think it's something that she thinks it's necessary for the SATs."
>
> (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 301-306)

This demonstrates how complex the issue is and that all actors exert forces and have forces exerted upon them. Here, the pressure comes from external assessment structures with this force appearing to be stronger than held beliefs and understanding of the research evidence. With government policies not matching equitable practice and requiring actions contrary to research evidence, teachers wanting to bring about transformability are placed in a very difficult position where 'the kind of teaching necessary to lift limits on learning is made a great deal more difficult by current government policies' (Hart, et al., 2004, p. 226).

Assessment and the external pressures this brings are particularly strong barriers to transformation as they set up a perceived requirement for strong within-school ability structures and change the pedagogy and curriculum content. Government policies lead to schools narrowing their curriculum, particularly in Year 6, to the content of the test and providing an objectives driven curriculum. Teachers are acutely aware of this and talk about it being "difficult actually, because there's expectations for the school, Ofsted expectations, external, you know, standards that need to be met" (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 210-211). Mr Iverson took this further, highlighting the issue but also noting how, as a school, they were trapped within it:

> "We're accountable to parents, we're accountable to the local authority, Ofsted and the government and they work with levels and as we still have the crazy system of testing in key stage two that's the way that we are judged so we have to go down that road because that's the currency that the government check that schools are working properly. I think that whole system is ludicrous, and actually there's much better ways of assessing and reaching standards rather than narrowing the curriculum to meet this coverage of curriculum by test, it's all about the curriculum, targets, and partly trust as well and it's about trusting teachers to do their job, also trusting head teachers to check that teachers do their jobs and spending more time on learning rather than maybe narrowing the curriculum to a particular test so that the school can be perceived to reach a certain standard which is very very narrow."
>
> (Mr Iverson, Avenue, Y4, S1, 16.07.08, Lines 168-179)

He notes that, although he sees the system as "ludicrous" it exerts such a powerful influence and is the way that schools are monitored. Mr Leverton also discussed the extremes to which statistical data is used to monitor schools: "these SATs are used for every type of assessment analysis that is possible, so the school end up teaching what is assessable rather than anything else" (Mr Leverton, Avenue, Y6, S4, 16.07.08, Lines 202-203). Schools are in a position where they feel they do not have the choice not to use these structures and all the implications that brings. This suggests how difficult transformation and removal of ability-based teaching would be. Teachers may want to bring about change, but do not have the power to exert change over some of the structures imposed upon them.

11.3 Why Transforming the Pervasive use of Ability Matters

The discussion in the previous sections of this chapter has suggested some reasons why bringing about change may be difficult. These range from the lack of capacity to see the use of an ability discourse as in any way peculiar and a lack of space to question current practices, to internal and external pressures, for instance from government policies. Further, many practices are consequential and sometimes unnoticed. The consequences of not noticing the impacts of an ability ideology, or in some cases being unable or unwilling to engage with these, are that practices continue and pupils continue to learn about their worth from the hidden curriculum operating in part due to an ability ideology. Where practices or their consequences go unnoticed or where teachers, for multiple reasons, find it difficult to affect change, bringing about sustained transformation will be very hard.

One particularly strong influence on teachers' practices is assessment particularly that used to externally judge the school such as KS2 SATs. It may be that even if teachers had the space to question these practices, the external force would be such that change would be very difficult. However, teachers contribute to the powerful force of external assessment through the high degree of trust they place in assessments, particularly external assessments, believing these to be 'proof' of attainment:

> Mr Leverton: "I don't want you in this group. You shouldn't be in this group. You above anyone else in this group (this is said loudly so all can hear) could be in even set 2, but you need to show it in your tests."
>
> (Avenue, Y6, S4, 05.03.08)

This extract was taken from a discussion in a lesson observation between the set-teacher, Mr Leverton, and Kayden, one of the higher achieving pupils in the set. Mr Leverton had previously stated to me that he felt Kayden should not be in Set 4 and was capable of the work in higher sets, but he consistently failed to demonstrate this in his tests and as such had been assigned to, and remained in, Set 4. It appears the Mr Leverton's teacher-assessment is not considered enough evidence of Kayden's attainment and that the only evidence that counts is what can be demonstrated through summative assessment. This belief was particularly strong in Year 6 at Avenue as the following interview extract shows, where Miss Gundry demonstrated a tendency to view SATs outcomes as correct, acting upon these without question:

> "I think that, the practice SATs, I think are most useful, because, I think, sometimes your teacher-assessment you think they might be coping very well or not coping so well and they really show you in a test situation, actually, do you know what I mean, they sometimes surprise you, you think, oh, actually, that person needs a bit more support or doesn't quite, because I think when you're teaching it's very teacher fed, you're explaining it, you're showing them what to do, you know you are giving them problems and things like that but you're really explaining what to do, aren't we, but in the test you've just got the question and they've got to, you know they don't have any sort of way into that so it's much more independent, so the practice SATs, I think they're so useful."
>
> (Miss Gundry, Avenue, Y6, S1, 16.07.08, Lines 103-112)

Miss Gundry appears to be discounting her teacher-assessment in favour of summative assessment, particularly where a mismatch occurs. Despite her having hours of individual, group and set contact with these pupils and the opportunity to talk to them, question them about their mathematics and probe their understanding, she deems the results of a written test, often focussing on single answers, to be more reliable in allowing her to know what the pupils are achieving. Not only does this highlight issues within teachers' understanding of assessment, but it also may add to the idea that mathematical achievement, particularly for Year 6 pupils, is not just a part of, but *is* summative assessment outcomes. This reliance on summative assessments is particularly concerning in light of Crooks' (1988, p. 440) finding that a 'substantial proportion of teachers have little or no formal training in educational measurement techniques', particularly so in primary education. Teachers in this present study put a high degree of trust in summative assessment outcomes without understanding the construction of these tests or how the outcomes should be used, particularly in terms of whether they referred to individuals or cohorts, with mock SATs and CATs all thought to give indications of an individuals' current and future performance.

Despite these erroneous beliefs about assessment, teachers are not to blame, for they are working within a system that encourages the use of these assessments in addition to other ability predicated practices. The challenge is to find arenas for change within this when it is so strongly supported by practices that seem 'right'. It is important that we do find ways to challenge current practices because without doing so we will continue to have an ability predicated system where it is deemed acceptable that only a small percentage of pupils are successful.

Under a pervasive reliance on notions of ability, many pupils are left feeling that they cannot do mathematics and hence have the tendency to disengage. This disengagement may also extend to more successful pupils who under ability based practices see mathematics as being about memorisation and assessment, lacking opportunities for collaborative work and challenge, something Ben notes in suggesting why mathematics can be boring:

> Ben: Well I enjoy maths but sometimes it gets a bit boring because you are doing the same thing over and over again.
>
> (Parkview, Y6, S1, 21.01.08, Lines 339-340)

This came through in the data where Year 6 pupils made more statements about disengagement in their interviews than Year 4 pupils. A particular issue that needs to be considered here is that disengagement was not seen negatively by pupils or teachers. Rather, it was seen as 'normal' behaviour. Olivia stated during her group-interview:

> "Okay, you know I don't like maths – it's kerfuffling and boring."
>
> (Avenue, Y6, S1, 29.04.08, Line 333)

Saying this elicited no negative reaction from the other pupils. Also, this was not said for a reaction from me but as a statement of acceptable fact. In their interviews, Miss Barton and Mr Donaldson talked about this type of acceptable disengagement:

> "I think, there's more times I would hear people say 'I don't want maths' or 'I don't like maths' than people would say 'I don't like literacy', 'I don't want literacy' … very often you hear people, adults saying about maths, but I think that's probably like Robyn or whatever, their parents will probably go, don't worry, don't worry mate, I was no good at maths, it's kind of all right to say I'm no good at maths whereas you don't say such things about writing or reading."
>
> (Miss Barton, Parkview, Y6, S1, 10.06.08, Lines 161-162, 171-174)

> "It's their attitude to maths, you know a lot of it, across the country I'm sure, even before the lesson begins, we're doing maths. Boring. You know. And you can have all the resources available, it might be this fantastic interactive thing you're doing but it just seems so much harder to actually draw them in and where's that attitude come from, is that from within the classroom, the teaching of it, that attitude to maths, have they got that outside of school I'm not sure, their attitude towards maths is generally different to their attitude towards Literacy or other subjects. I mean a lot of them, their family, their home life will be, oh I know, I didn't like maths really, they just come in with it almost."
>
> (Mr Donaldson, Parkview, Y4, Class 1, 21.07.08, Lines 119-127)

Both teachers make links with literacy suggesting that the type of disengagement seen in mathematics would not be acceptable in literacy. Mr Donaldson suggests that this phenomenon of disengagement is countrywide, possibly taking away responsibility from teachers for developing engagement in the subject. This disengagement appears not just to be tolerated, but actively accepted. This mirrors social norms and understandings of ability and intelligence with an acceptance of the way things are rather than a suggestion of the need for change.

11.4 Is Transformation Possible?

In this chapter I have examined some of the ways in which pupils identify aspects of ability practices as unjust and have also looked at teachers' concerns. I have highlighted teacher change as complex with some teachers wanting change, others being tied by entrenched practices and many unaware of the complex reproductive processes taking place. I have also suggested that the forces acting against transformation are multiple, being both external and internal – to the schools and teachers – and complexly interwoven.

Concern about the pervasiveness and impacts of ability is not new. Previously there have been studies, many small-scale, short-term or politically sensitive, considering possible ways of doing things differently. The majority of these have been US based, focussed on de-tracking (see for example Mehan & Hubbard, 1999; Rubin & Noguera, 2004) or teaching methods for heterogeneous mathematics classes (see for example Boaler, 2008). They have also tended to be based in secondary education. A notable exception to these is the Cambridge Learning without Limits project (Hart, et al., 2004) set up in 1999 to consider ways of teaching free from notions of fixed ability, both in primary and secondary education. It is worth noting that although Learning without Limits posed a viable alternative and there have been a number of follow-up projects, their transformability approaches have not been widely adopted, due in part to the external forces on schools to retain ability based practices. Beyond Learning without Limits there have not been other UK based larger-scale projects exploring alternatives to the use of fixed-ability models in practice.

The key message of this chapter has been that, whilst there is some awareness of the difficulties associated with a fixed-ability approach, much is unnoticed, and hence very little challenged. Bringing about change is likely to be very difficult even if the consequences of ability are fully realised, due to the multiple pressures on schools and teachers to retain ability-based practices. These pressures have resulted in there being few alternatives to using fixed-ability models in primary education.

In the following final chapter I bring together the above with the other key findings of the study. I also extend the discussion in this chapter of the difficulties associated with change to consider how things could be different, what possibilities there are for change, and who should take responsibility for this.

12 Production, Reproduction and Transformation: Discussion and Reflections

12.1 Introduction

In this thesis I have presented and analysed data from different school environments to explore the multiple, interrelated ways in which a pervasive discourse of ability acts upon teachers and pupils to limit the mathematical opportunities for all learners. Additionally, it stifles creativity and exploration, reproducing a pervading social belief in which only a select few are born to be ‘good at maths’. In this final chapter I set out the major findings of this research to present a coherent picture of the current situation in primary mathematics. In doing so I describe how this study adds to the existing literature, taking our knowledge in this field forwards. Further, I address issues of generalizability – taking into account the limitations of this study – arguing for the power of these findings to be applicable beyond the specific schools studied. In suggesting that the results are rigorous and generalisable, I explore the implications of this study for education and policy, contemplating how things could be different, where change could be instigated, and what this might look like.

12.2 Contribution to Knowledge

This study highlights many important issues related to ability in primary mathematics. These have been discussed in detail, alongside presentation of evidence for these claims, in the preceding chapters. In this section I draw these issues together, discussing the four major findings of this research which contribute to our knowledge. These four findings are drawn from across the chapters. In the following section I discuss how these answer the research questions. Within this thesis, quantitative and qualitative data were presented separately for ease of analysis. The data chapters drew heavily on the qualitative analysis which represents the strongest element of this study. This was essential in identifying and developing a deep understanding of the various processes occurring. The qualitative analysis formed the basis of each theme discussed within this thesis and of the four key findings. The quantitative analysis provided some evidence of apparent regularities within the data as set out in section 6.2, as well as identifying areas where there appeared to be few associations within the data, hence emphasising the need for the qualitative analysis.

Within the sections below I predominantly draw on the qualitative data, additionally highlighting the role of the quantitative analysis in these findings. This integration justifies the labelling of this study as mixed-methods and ensures a rigorous discussion.

12.2.1 Ability is a strong, pervasive discourse in primary mathematics

A key issue emerging early in my visits to Avenue and Parkview Primary schools was how pervasive ability was as a discourse across the schools. Understood by teachers and other school staff as an innate, genetically determined indicator of individual capacity, ability was widely used as a natural part of everyday language with an assumed shared understanding and belief system. The use of ability – whether in discussing individuals or groups, allocating resources, or making decisions about practices – pervaded the school day, impacting across subjects and age-ranges. It appeared particularly strong in Year 6, catalysed by the intense assessment regime of the SATs. In addition to the qualitative data, this was evidenced through the complexity in the quantitative data related to beliefs about the causes of success particularly in relation to competitive beliefs.

In many cases, well-illustrated by the Parkview head-teacher's lack of awareness of the extent of ability-grouping in her school (see Chapter 5), school staff were blind to the dominant place and role of ability in dictating both explicit practices and implicit or consequential outcomes. So much of the inequitable practice occurring could be traced back to a pervasive belief in innate ability and limited potential. This limited potential, or agency in affecting change, was seen in the long tail of weak self-beliefs and limited change between the pre- and post-tests in the quantitative data. However, in the same ways White (2006) argues we have lost the capacity to see our everyday use of intelligence as in any way peculiar, there seemed to be a lack of awareness of just how pervasive ability is and just how much it invades teaching and learning in primary mathematics. I had initially intended to investigate pupils' and teachers' transformation of ability – their challenging and changing of the dominant discourse and practices – yet such challenges were incredibly rare, only occurring in teacher interviews where they had the space to explore school structures and pedagogic issues, and not translated into practice. The unchallenged normative use of ability within primary schools, reflecting social discourse, has been reproduced across generations. Ability is such a strong and pervasive discourse that change will be very difficult.

As a consequence of teachers' beliefs about ability, they readily bought into 'neuro-myths', the most common to pervade education at present being learning styles. Teachers framed pupils' learning differences in terms of learning styles from auditory high-ability pupils to kinaesthetic low-ability pupils. Pupils reproduced such differences as natural with the potential to lead towards an intensification of innateness beliefs. Overall, pupils' productions of ability and what it meant to be high- or low-ability in mathematics were strongly aligned with teachers' and social beliefs. Pupils spoke of a strong belief that you had to be 'born to be good' at mathematics and that there was little they could do to upwardly change the ability level they had. Demonstrating this, they had little trouble in placing themselves or their peers within an ability hierarchy. Across the dataset there was strong stability in pupils' self-positioning of their perceived ability with no significant difference in perceived ability scores at the beginning and end of the research period.

This study only looked at mathematics classrooms so the evidence across subjects is limited to teachers' and pupils' spontaneous comparisons with other subjects, yet it appears from these that mathematics may be a particular case. Being mathematical was thought of by pupils as somehow different to high-achievement in other subjects, particularly literacy, which pupils often used as a comparison. Whilst high-achievement in literacy was thought of as theoretically open to anyone, pupils felt individuals had to possess an innate predisposition towards mathematics – alongside high levels of memorisation – in order to be mathematical. This belief was intensified by teacher practices whereby pupils were provided with 'up-levelling pyramids' as a cue to attaining higher levels in literacy. No similar resource was forthcoming in mathematics where both teachers and pupils were caught within an ability belief of individual predetermined limits to achievement, with neither the pupil nor teacher having agency to bring about change.

12.2.2 Ability's impacts are similar in primary and secondary mathematics

As discussed in chapters 1 and 3, this thesis addresses a significant gap in our understanding of ability in mathematics education, considering the relevance of the extensive secondary mathematics literature to the primary context. It was expected that whilst the secondary literature would be important in providing a background in how ability may impact on primary mathematics education, the primary culture was different enough that ability would be found to play out in very different ways.

The degree of congruence between my primary mathematics findings and the secondary mathematics literature was concerning. The quantitative analysis suggested that at Avenue, a process of educational triage occurred, as has been found in the literature at GCSE level. Pupils who, with additional input, would achieve a Level 4 in their Year 6 SATs – and hence improve the school's league table position – were sorted into Set 3, whilst those pupils who would not achieve this level were placed in Set 4. These sets moved apart significantly in terms of attainment gains over the academic year; Set 3 made a median gain of one year and 4 months in comparison with the Set 4 median gain of 3 months. My qualitative analysis suggested how these differences may have come about, with Set 3 purposely given the 'best' teacher and an enhanced curriculum whilst Set 4 were taught by HLTAs and supply teachers and given a remedial curriculum that left them unable to move from their ascribed position.

The style and characteristics of the set lessons I observed at both schools reflected many of the characteristics of set secondary school mathematics lessons widely discussed in the literature. Even where within-class grouping was used, many of these differential practices remained, even if enacted more subtly. Top-set lessons, focussing on procedural learning rather than on learning for understanding, were fast paced, with pupils racing to produce as many answers as possible. This competitiveness led to pupils being self-interested rather than concerned with working cooperatively. Bottom-set lessons, drawing on the perceived need for a kinaesthetic approach, had a heavy reliance on the use of manipulatives. There was greater focus on behaviour and a higher incidence of behavioural reprimands than in top sets. Lessons were slow-paced, focussing on repetitive practices and 'small numbers', restricting access to 'hard' mathematics and hence widening the attainment gap and producing and reproducing very limited mathematical identities. However, it is important to note that in many cases, teachers believed they were acting in the best interests of the pupils, performing caring and protective roles in ensuring their pupils were not frightened or distressed by the mathematics. There is some evidence, for instance in Mrs Jerrett's interview discussed in Chapter 8 as well as in the wider literature related to this study (e.g. Hodgen & Marks, 2009), to suggest that some teachers, who had themselves had difficult experiences in school mathematics, were trying to protect themselves whilst also feeling the need to protect their pupils. At the same time, they were working under a pervasive discourse of ability and did not have the confidence or knowledge to do things differently; hence they reproduced the negative teaching methods they had encountered at school.

A consequence of both top and bottom-set approaches was that opportunities for all pupils, which may have impacted on mathematical attainment, were limited. In particular, supportive peer relationships, peer discussions and collaborative work were virtually absent: in top sets due to pupils' competitive self-interested approach and in bottom sets due to behavioural reprimands and teacher control. Pupils talked about valuing working together, and of this supporting their understanding, having experienced it within occasional whole-class mathematics lessons and in other subjects. They saw setting, as shown in the secondary literature, to be directly attributable to the loss of opportunities for collaborative work, which, some felt, impacted on their understanding. This qualitative data added depth in understanding the complex associations produced in the quantitative analysis in relation to enjoyment and beliefs; a complexity which mirrors the secondary literature.

Some issues arose in this research with limited consideration in the secondary literature. In particular, pupils very quickly took on their ability-group label as a self-description – referring to themselves as a snow-leopard, a green person, or as being 'the bottom-set' – allowing something complex to be seen very simplistically. This was particularly strong in Year 6 where pupils, as has been shown in previous research (Reay & Wiliam, 1999), readily took on National Curriculum ability identifiers, seeing themselves as their ascribed level. This issue is likely to have a greater impact in the primary context due to the emphasis on literacy and numeracy. Further, there was some evidence that the impacts of ability practices may be stronger in the primary school environment where the physical structure and caring ethos are not suited to secondary setting practices, as discussed in more detail in section 12.2.3. I would argue that ability has the potential to have a more significant impact on pupils at the primary level than the secondary level – where the impact is still strong – inducting pupils into widely held social beliefs and setting them up to understand, and accept, their place within a mathematical-ability hierarchy.

It appears that overall the secondary mathematics literature in relation to ability and setting can be applied to the primary context. Indeed, there is nothing within this existing literature that appears *not* to apply and there are other practices occurring more strongly, such as the ready uptake of National Curriculum identifiers, which may make the impacts of ability more striking in the primary mathematics context.

12.2.3 The impacts of ability and ability-grouping go beyond explicit practices

Many research studies exploring ability in either primary or secondary mathematics focus on setting, this being a key practice predicated by the ability beliefs held by teachers. However, as discussed in section 12.2.1, ability is pervasive across education and not constrained by specific practices. This study found ability to be so pervasive that its impacts extend beyond those directly attributable to setting, additionally being found where other forms of ability-grouping and mixed-ability organisations are used. These pervasive impacts beyond setting may be implicated within the quantitative associations which suggested complexity in the affective data; if the impacts go beyond setting we would expect other factors to come into play in directing pupils' beliefs. Here the qualitative data was vital in understanding the practices occurring and their impacts.

Previous research in secondary mathematics has highlighted what happens, particularly in terms of curricular access and teaching styles, within setted classrooms. These are important studies and the present research found the same to be happening in primary classrooms, as discussed in section 12.2.2. However, this study also found evidence that more happens beyond and around classes segregated by ability, with the impacts seen from the very beginning of the school day. The traditional image of the primary school, and the one the environment is set up to support, is of the class teacher taking responsibility for the pastoral care and education of their class across subjects and the school day, within the confines of their classroom base. This will be interrupted at points – for instance for assembly and P.E. lessons – yet overall the teacher and pupils remain in close contact.

Setting disrupts this traditional approach, removing pupils from the care and understanding of their regular class-teacher and eliminating the flexibility to start or end lessons at different times. Within the year I spent at both schools, evidence of this was seen several times. Form-teachers rushed the start of the day and felt unable to deal with pastoral issues – for instance a child who came into the classroom upset – in order to send the pupils to their sets and begin the setted lesson. Teachers were less aware of the needs of particular pupils in their sets as they only saw them for mathematics. Mathematics became seen as a stand-alone subject as teachers could not easily make links to other aspects of pupils' learning. The end of the lesson was dictated by the clock, not by pupils' learning needs with no opportunity to continue lessons or follow-up interesting diversions as occurred in non-setted classes. In essence, setting removed, in the teachers' minds, the complexity of education, the focus became only about the mathematics and success in mathematics came for those pupils able to ignore their wider-identities.

A further impact of setting in the primary school environment, particularly salient at Avenue but also seen at Parkview and anecdotally understood to be an issue across many primary schools, related to the physical space. Whilst secondary schools are generally designed with class movement in mind, primary schools are not. Where, as at Avenue, and in Year 6 at Parkview, more sets than classes are created, some pupils, often the bottom sets, are left without a stable classroom base. The insecurity of a lack of place and the physical restrictions this placed on these sets – for instance not having a whiteboard, mathematical resources, or having to conduct lessons in corridors – added to the curricular and teaching restrictions already placed on these pupils. Whilst teachers understood the restrictions imposed by inappropriate environments, they interpreted pupils' behaviours in the classroom, many of which were a reaction to the environment, as innate behavioural difficulties. These were then used as evidence in teachers' productions of these pupils as low-ability, hence justifying their differential approaches.

Even where ability-grouping is not used or in practices that transcend primary mathematics, ability is so pervasive that it continues to have an impact. This was seen in the extensive identity work teachers and pupils partook in – discussed in detail in the following section – clearly demarcating pupils by reference to ability even where groups were not used. Assessment practices are clearly strongly tied to ideas about ability, yet these have an impact on productions of mathematical-ability beyond the mathematics classroom. This was seen at both schools in relation to secondary school selection. Admissions criteria, whether for selective or non-selective schools, intensified and naturalised discourses of ability, feeding into beliefs of innate unchangeable ability levels through practices such as the banding of pupils. Even in Year 4, pupils demonstrated a strong awareness of secondary school selection, using this within their understanding of pupil difference. These findings suggest that if we are to change the pervading stigmatising discourse of ability we need to look beyond the most explicit practices, with change going far deeper.

12.2.4 Both teachers and pupils co-construct identity and ability

Pupils, through a reproductive process, developed productions of ability, understanding prevailing beliefs and what it means to be labelled high- or low-ability. They understood their place within the ability hierarchy and produced an enactment of this label with specific behavioural responses for specific ability labels. However this enactment was not a solitary process. In particular, pupils worked in co-construction with the mathematics teacher to maintain their position but also to ensure that other pupils maintained ascribed positions and did not pose a threat to their ability-identity. This co-constructive identity work between the teacher and pupils is often elaborate and nuanced, yet whilst the enactments appear very deliberate they have become such natural responses that they are often conducted without awareness. Despite this lack of awareness, pupils do notice some differences in the teachers' interactions, with these differences feeding into their ability productions.

A key area of identity work occurs in teachers' responses to pupils' behaviours. This was discussed in detail in Hodgen & Marks (2009) in which the teacher was seen to improvise (Holland, et al., 1998), acting as if the witnessed off-task disruptive behaviours of pupils labelled as high-ability had not occurred, drawing attention only to the mathematical outcome. Similar off-task behaviour was seen from low-ability pupils in the present study; here the teacher reprimanded the behaviours and ignored the mathematics. These responses fit the production of the norms of what it means to be good or bad at mathematics, allowing or ensuring the pupils involved maintained their ascribed identities.

High-ability labelled pupils were seen to spend a great deal of time working on maintaining their identity through their behavioural projection. Pupils held a shared understanding of how those labelled high-ability should act. Such labelled pupils worked to create a façade of this, although it should be noted that what actually lay behind this could be very different. High-ability labelled pupils needed to display enough effortless success to maintain their position without tipping into the discourse of weirdness and other-worldliness. Managing this saw them engaging in behaviours such as putting up their hand when they knew they would not be asked or carefully modelling their verbal engagement on stock teacher phrases. Such behaviours, elucidated through the qualitative aspects of this study, may suggest factors at play in the quantitative identification of set placement overlap where it was suggested that additional factors were brought into teachers' judgements of pupil ability. Teachers also played an important role, helping to co-construct high-ability pupils' identities. In addition to ignoring behaviours not fitting such an identity, teachers engaged in a different quality of discussion with high-ability pupils, using techniques such as re-phrasing and funnelling to ensure pupils came across as producing the correct answers.

Different co-constructive identity work occurred with pupils labelled as low-ability. Much of this was the opposite of that seen with high-ability pupils, focussed on reprimanding poor classroom and learning behaviours, or limiting mathematical interaction through lack of, or limited, engagement. Where low-ability pupils enacted behaviours thought of as more suiting a high-ability label, teachers improvised to turn around the incident and ensure 'correct' identities were maintained. A further specific co-constructive process occurred with pupils identified as having SEN. Through 'unconscious collusion' (Youell, 2006, p. 98) teachers enacted a caring position of protecting these pupils from 'hard' mathematics, whilst some pupils took on a helpless role in which they saw themselves as unable to attain any higher. This is an important qualitative finding in that it supports the quantitative finding of a long tail of weak self-beliefs, and in particular of limited capacity for change, helping to explain why such an association in the quantitative data may have arisen. Where pupils with SEN did achieve highly, improvisation allowed aspects of their behaviour to be focussed on and for the attainment to be reconceptualised as a fluke. This process served two purposes: it allowed teachers to justify differential practices but also strengthened all pupils' productions of ability in which SEN was seen as incompatible with high-achievement in mathematics.

This finding suggests the extent to which all pupils, but particularly those labelled high-ability, are engaged in an enormous quantity of non-mathematical identity work within mathematics lessons as a result of ability-based expectations, all of which detracts greatly from their mathematics learning. These pupils are spending a great deal of time, either individually or in co-construction with the teacher, managing their outward behaviours in order to maintain their ability-identity. This suggests further the extent to which ability impacts on pupils' learning in ways that may not be immediately obvious.

12.3 Addressing the Research Questions

In chapter 1 I set out the objectives of this study and the research questions designed to address these. Here I explain how the findings discussed above answer these questions.

- *In what ways is ability produced, reproduced and transformed in the primary mathematics classroom?*

- *What is the role of pupils in producing, reproducing and transforming their own and others' mathematical-ability?*
- *What is the role of teachers in the production, reproduction and transformation of pupils' mathematical-ability?*
- *What effects does ability have on pupils' attainment in and engagement with primary mathematics?*

I had originally intended to provide separate answers to these questions. However, an important finding of this study was how interrelated the processes of production and reproduction were, how actors worked together in these processes and how the effects were part of the reproductive process. One aspect that has only been addressed in a limited capacity in this study is transformation. This in itself is an important outcome, for it was found that challenge to the dominant discourse and practices of ability is incredibly limited. Understandings of ability are produced by pupils and reproduced through and beyond classroom practices to reflect prevailing social discourses. Whilst teachers are aware of some of the research evidence pertaining to the stigmatizing impacts of ability based practices and can engage with this in an interview context, this understanding does not translate into changes in practice where external performative pressures support the continuation of iniquitous practices.

Pupils and teachers were found generally not to have solitary roles in producing and reproducing discourses of ability but to work in a process of co-construction, improvising enacted behaviours to ensure the preservation of previously ascribed ability-labels. Both pupils and teachers invest a great deal of time and effort within the mathematics classroom in identity maintenance yet much of this is a normalised response, a practice they conduct without explicit awareness.

The effects of ability on attainment and engagement, which are part of the reproductive process, come about in very similar ways to those documented in the secondary mathematics education literature. In many ways, the practices and effects of ability in primary mathematics could be seen as apprenticing pupils into fixed ability ways of thinking, ensuring these are accepted as they move into secondary education. The processes occurring work very successfully in bringing about this apprenticeship with pupils accepting and enacting their position within the hierarchy. The processes are particularly successful for they all – both in and beyond the mathematics classroom – work under the same social ability beliefs, providing a consistent message to pupils, reproducing, with little transformation, their ability productions across all aspects of their lives.

12.4 Critical Realism as a Theoretical Approach

As discussed in Chapter 2, and will be clear through a lack of explicit reference in the recent chapters, my use of critical realism has changed substantially over the course of the previous and present studies. However, this lack of explicit reference does not signal an abandonment of this approach, but rather a change in emphasis. A critical realist approach has been important in providing guidance both to me as a researcher and in conducting this study. In this very brief section, I outline four key areas in which critical realism has benefitted this study: supporting multiple perspectives, theoretical and conceptual development, methods and analysis, and implications for change.

Supporting multiple perspectives

As a teacher I engaged in the ability practices discussed in this thesis. I found it very difficult when it came to questioning such practices to understand why I had engaged in them without challenge. However, critical realism allowed me to understand the roles and processes in play with a concept such as ability; it also allowed me to work simultaneously with my developing understanding as a researcher as well as my understanding as a teacher. This proved to be salient when conducting and analysing teacher interviews particularly where teachers spoke with an understanding of the research evidence yet engaged in contrary practices within their classrooms.

Theoretical and conceptual development

Central to this thesis is the concept of ability. Whilst the research explores the understandings and ideology of this concept rather than engaging with ability as an attribute, it was nevertheless important to set out my position. Critical realism, its position on unobservable entities and its work on structural mechanisms was essential here. It enabled me to bring together neuro-scientific understandings, aspects of ideology and the wider literature in developing a realist / critical realist account of what ability is, providing a clear baseline setting out my position from which this thesis could be read. Further, a critical realist approach was beneficial in setting out, and bringing together, my approaches to discourse and identity as detailed in section 2.4.

Methods and analysis

A critical realist perspective was particularly important within my methodological approach. It allowed me to detach a range of powerful research methods from their theoretical backgrounds and to take a mixed methods approach. Each of these was discussed in detail in chapter 4 (see Section 4.1.1) and as such I do not repeat them here. Further, a critical realist perspective was important during data analysis. As discussed above, it allowed me to consider multiple perspectives for instance where teachers and pupils talked about issues or concepts in different ways whilst the critical realist tenet of judgemental rationality allowed me to make a judgement between different possible analyses. Additionally a critical realist perspective proved to be supportive when analysing my data in terms of transformation; critical realism provided a potential explanation for the lack of transformation seen and allowed me to explore it from different angles looking, for instance, at reproductive transformation where actions were changed to ensure stability in outcome.

Implications for change

At the end of this chapter, in section 12.8, I discuss the implications of this study for education and reflect on the possibilities for bringing about change to the current situation outlined in this thesis. A critical realist perspective, as a background guiding meta-theory, has been essential in holding in mind the impetus for conducting this research and in continuing to think about what changes might be needed for, or how emancipatory action can be brought about. In essence, a critical realist perspective has ensured that I have continued to think about what this thesis has been working towards: the possibility of change.

12.5 Generalisation of Findings

I have made some strong claims in this thesis. Although I emphasise that I do not see blame as residing with primary teachers, the findings may not sit easily with current practitioners. Some may suggest that my findings are only applicable to the Avenue and Parkview Primary School settings but I would argue that they can be applied more generally on multiple bases. My belief is that such generalisations are justified and therefore likely to be sound. As such I feel confident in making the education and policy recommendations in section 12.8.

Avenue and Parkview Primary schools were selected for inclusion in this study because they were typical of other schools in similar environments. They represented the different forms of organisational structures in multi-form entry primary schools and as such the findings in the discussions above can be seen as applicable to multiple school organisations. Although Avenue was a high-attaining school in its league table position, this reflected the highly competitive secondary school selection in the local authority. Inclusion of such a school was essential in examining the impact of wider selection practices, conducted within social beliefs of the innateness of ability, with these being applicable across school contexts, as shown by the selection data from Parkview school. Both schools had average contextual value-added scores suggesting further the typicality of each and therefore the applicability of these findings to other schools.

The processes identified in each school were not unusual. I have witnessed similar issues across different schools in research and teaching contexts. Additionally, feedback I have received when presenting this study suggests that the findings chime with the practical experiences of other researchers and academics working across a range of primary schools. This again suggests the typicality of the Avenue and Parkview school contexts.

Many results in this study mirror the secondary school literature on ability. This suggests the pervasiveness of ability and the inherent difficulties in bringing about change, but it also gives further reassurance in the robustness of the findings and increases the likelihood of generalisability as these processes have been rigorously tested elsewhere.

A further argument for generalizability comes from the study's approaches. Through spending a whole year in the schools I was able to develop strong relationships with the staff and pupils and achieve an extensive insight into the issues affecting them that may not have been possible with short-term research. The mixed-methods research design with multiple participants enabled me to examine phenomena from a number of perspectives allowing triangulation across data types and ensuring that the data presented were representative rather than extreme cases. Further, taking a critical realist perspective, particularly with its focus of judgmental rationality, enabled me to have confidence in the interpretations I made, ensuring the results were rigorous and hence the findings generalizable.

12.6 Limitations to the Study

Whilst in the previous section I argued for the generalizability of the findings of this thesis, there are inherent limitations which should be kept in mind. The context in which this research was conducted, the results analysed, and the findings discussed, was specific to the English education context and to mathematics. In section 1.2 I noted particular features of the English education system relevant to this thesis, namely the centralising policy of the NNS and the particular ability-grouping systems marking the UK out as different from other countries. As such, the findings should be read within this context and care taken in extrapolating them to other countries or disciplines.

Further, although the original intention was to include one fully-set school and one school employing no ability-grouping, this proved to be impossible, with Parkview using setting in Year 6 and some within-class ability-grouping in other years. As such, the results of this thesis can only be extrapolated with certainty to schools having similar systems. Other schools, particularly smaller schools where between-class grouping is not feasible, may have different experiences with respect to ability although it seems likely given the finding of ability as such a strong, pervasive discourse, that they will still experience ability in similar ways.

Other limitations relate to the research design and methodological issues. As a lone researcher, pragmatic decisions had to be made about what was feasible with regards data collection and analysis within the time available. This study had to be small scale, including only two schools, looking at only top and bottom sets (at Avenue) and focussing only on Years 4 and 6. This leaves open questions about what might happen in other schools, sets and year groups; some such questions have been addressed in considering the generalizability of this study whilst others open up the study to further work (see section 12.7). Additionally, as a lone researcher, the data collection is my own. Whilst participant validation was used with some aspects of the interview data and inter-coder reliability checks made, the analysis will always be open to arguments of researcher bias or prejudice. However, I believe that I have accounted for this throughout this thesis, particularly in section 2.2 in which I discussed the position of myself as a researcher and the influence of my biography.

12.7 Extending the Study

This study provides a significant addition to our knowledge and highlights many important issues relating to beliefs about, and the use of practices arising from, a dominant discourse of ability. However, there are areas outside of the scope of this study where there are gaps in our knowledge and the study has also revealed areas where further research is warranted.

This study has shown that ability is incredibly pervasive in primary mathematics education to the extent that practices seem so natural they may occur without a full awareness of their use. Many people outside of education are shocked to hear of the use of setting or streaming in the primary sector and assume it to be an isolated rather than wide-spread phenomenon. Previous studies have found it difficult to reliably ascertain the true extent of ability-grouping as methodological issues – for instance the lack of shared understanding of terminology used or head-teachers lack of awareness of what is actually happening – can lead to inaccuracies in survey research. Additionally, many primary schools, unlike those in this study, are one-form or mixed-age entry making between-class grouping difficult to administer. Factors such as feasibility need to be taken into consideration when designing and reporting on studies of prevalence. Such a study is important if we are to understand the more widespread impact on pupils and the beliefs they are developing prior to embarking on secondary mathematics.

I noted in discussing the finding of pervasiveness that I had only conducted the study within the context of mathematics. I have suggested throughout this study that mathematics may present a special case given how it is conceptualised within society. It would be important in understanding more about the pervasiveness and impact of ability to conduct similar studies within other curriculum areas. This would allow an evaluation of if and how mathematics is special and may also suggest possibilities for change where non-ability based practices can be transferred from other curriculum areas into mathematics.

Whilst this study claims to research ability in primary mathematics, it, along with its pilot studies, was solely located in Key Stage 2. I set out the rationale for this in Chapter 4 and a KS2 focus does not make the findings any less important. However, ability-practices are different in the Early Years and KS1 with greater within rather than between-class grouping. Whilst this study found within-class grouping, and even no grouping, to still convey strong messages about ability, it would be important to understand how the practices younger children experience impact on their beliefs about themselves and others and what they take with them into KS2. An unexpected finding of the present study was just how strong the ability beliefs of Year 4 pupils (and Year 3 pupils in the pilot) were, with a direct reproduction of social beliefs. Some early work currently being undertaken in Australia (Evans, 2010) suggests that Kindergarten children are yet to develop entity beliefs about ability. This may be due to various factors including a developing awareness of the self and others, and family input. However, by understanding the development of pupils' beliefs during the first few years of schooling we may gain a deeper understanding of how reproductive processes work and how pupils are apprenticed into socially held beliefs. By understanding this, there are potentially avenues for bringing about change in current practice in order to limit such reproductive processes which currently construct the majority of pupils, from a very young age, as 'bad at maths'.

12.8 Implications for Education and the Possibility of Change

> 'A teacher without time to think is like an artist asked to paint without being able to stand back and look at the results of what she's doing. And when, in the end, she sees that her picture is a flop, she blames not her restricted space, her need to work very fast, her inability to stand back and take cogent squints at her latest brush strokes. No, she blames the canvas.' (Pye, 1988, p. 174)

This study has suggested multiple negative implications arising from the past and current dominance of a discourse of ability and its associated practices across primary education, particularly in mathematics. The current system limits opportunities for all pupils – in different ways – and decreases the likelihood of positive engagement. Linked with the current literature in secondary education, this has the potential to restrict future engagement with the subject, reducing the probability of pupils continuing to study mathematics in post-compulsory education or developing a confidence in the subject to serve them in many aspects of adult life. Further, and most importantly, we have seen that many teachers currently reproduce the stigmatising discourses and practices related to ability that they were subject to; unless change can be injected at some point, then this reproductive pattern is set to continue.

As I hope I have made clear throughout this thesis, although many aspects of change will need to focus on, or come from, teachers, I am not blaming current practitioners for the situation we are in. This study has shown that they are often unaware of the real or fuller implications of their practices, enacting these on the premise of care. Without the time or space to think about and engage with these processes, teachers continue to partake in practices mirroring social beliefs as these appear intuitively correct. Further, external pressures – for instance Government policy or parental pressures – both further legitimise such practices and place enormous pressures on schools to enact particular practices. These multiple pressures, lack of space for engagement and social beliefs highlight why change is so difficult, for there will always be competing pressures on teachers to maintain current practices. However, some studies have shown, at least on a local basis, change to be possible, and in this final section I consider how such change could be brought about.

One important arena for change must be in policy. Given that ability predicated practices appear to influence pupils' self-perceptions we should be questioning Government recommendations (e.g. Bew, 2011; Gove, 2007) which encourage such practices within schools (for further discussion of the role of policy in ability constructs in primary mathematics see Marks, 2005). Bringing about change here involves convincing policy makers of the need for change. Such policy makers are likely to be those who have benefitted most from ability-based practices and who would feel they have the most to lose from change. Without change, they may continue to reproduce/use transformative-reproduction to maintain the status-quo and continue to help themselves.

A number of the findings of this study suggested that teachers enacted particular practices, for instance educational triage, as a direct result of actual or perceived external pressures. I would like to see a culture where teachers are treated as professionals, trusted to do the right thing for their pupils and where they are not fearful of external pressures and surveillances which may drive them into practices they do not have time to evaluate or are not ideologically comfortable with. Teachers currently undergo regular inspection and appraisal and yet they do not have the time or freedom to inspect or appraise the practices they are led to believe are right or which are expected of them through policy dictation from those removed from education.

If teachers were given the space and time to really engage with the practices that have become so normalised that they go unquestioned, we could develop a culture where questioning and experimentation are the norm. As Pye's (1988) quote at the start of this section suggests, such time out to reflect and perhaps partake in professional conversations with colleagues could provide teachers with the time to think about their practice and that of others. Currently, teachers lead fairly individualised lives and the same ability-predicated practices and pressures which are detrimental to pupils may also place teachers in competition with each other. Giving time to explore what is happening may make them more reflective, thoughtful and essentially 'better' teachers. This happens in other professions whereby professionals are taking on so much (e.g. therapeutic and medical settings) so why not in an educational context? To do so would require a sustained commitment to the pastoral care of teachers (Carroll, 2010), giving them the opportunity to care for themselves as well as their pupils. Doing so, although contrary to much current practice in education, as Peacock (2006) found in looking at when teaching staff were asked about their views, may enable them to see the reproductive and stigmatising processes they are involved in. This would ensure that whilst they continue to demonstrate care for their pupils, this is not done in such a way as to limit pupils' opportunities.

Whilst such 'space to think' seems to hold potential, change is likely only to occur under guidance whereby teachers are set up with powerful spaces in which to work together for change. As Deppeler et al. (2010) have argued for, teachers require access to non-fragmented, sustained professional development which has an input of, and for, the whole school rather than for a teacher working alone. Professional development needs to have a research element exploring theory and pedagogy rather than being a single 'tips and tricks' event if it is to really allow teachers to engage with practices and work to bring about change. This of course has time implications and hence also requires the commitment of school management, and, if it is to be used more widely, Government policy support. The level of engagement Deppeler et al. argue for requires input from higher education in the dissemination of, and involvement in, research. However, it may be equally appropriate for this involvement to happen earlier with a greater research input into Initial Teacher Training. It could perhaps be argued that researchers have a responsibility to ensure teachers know about, and implement, research findings, tackling issues currently missed out in training.

Reflection would require teachers to engage with everyday practices and see the reproductive and stigmatising elements of these. Additionally I believe there is a need to change some of the fundamental pedagogic approaches, many arising from or constrained by ability beliefs, which limit pupils' engagement with mathematics. One example of this would be to allow pupils to make mistakes, seeing exploration as part of the process of learning rather than something to be avoided. Through re-framing mistakes as a process of continual practice, school mathematics aligns more with the mathematics used by mathematicians. A number of pupils within this study, particularly those in top sets, talked about their fear of making mistakes and the reaction from the teacher and ridicule from other pupils if they failed to maintain their high-ability identity. To remove this fear would allow deeper engagement and would additionally remove elements of the extensive identity-work pupils are currently engaged in which detracts so much time from the learning of mathematics.

These suggestions for how things could be different may seem idealistic, but without quite extensive change, we are going to see the continual reproduction of the discourses and practices this study and many others have found to be so stigmatising to some of the youngest learners of mathematics. I would actually like to go beyond these recommendations, to see an education system where there are genuine high expectations for all rather than the current system in which so many are sacrificed for the sake of a very few. To do this would require a huge shift in societal attitudes and the removal of the belief that only a few ‘chosen ones’ can ever be good at mathematics. Such a shift would require us to break free from the comforting innateness barriers that justify current practices and not only allow, but encourage, individuals to be self-deprecating about their mathematical attainment. To do so would allow us all, and particularly future generations currently in schools, to, as Shenk beseeches, ‘rise together’:

> ‘A laissez-faire society *will* bring great achievement. The most competitive will rise to the top, at the expense of others. Competition will know no moral boundary. Society will, in every way, become more and more extreme, producing some great achievers and many unfortunate losers … But this sacrificial ethos is not the sort of humanity we seek. Instead, we embrace the agonistic ideal: healthy rivalry, high expectations, respect and compassion for all. The genius in all of us is that we can rise together.’ (Shenk, 2010, p. 129)

Bibliography

Adey, P., Csapó, B., Demetriou, A., Hautamäki, J., & Shayer, M. (2007). Can we be intelligent about intelligence? Why education needs the concept of plastic general ability. *Educational Research Review, 2*(2), 75-97.

Alexander, R. J. (2000). *Culture and pedagogy: International comparisons in primary education*. Oxford: Blackwell.

Alpert, B., & Bechar, S. (2008). School organisational efforts in search for alternatives to ability grouping. *Teaching and Teacher Education, 24*(6), 1599-1612.

Anastasi, A. (1982). *Psychological testing* (5th ed.). New York: Macmillan Publishing Co.

Ansari, D., & Coch, D. (2006). Bridges over troubled waters: Education and cognitive neuroscience. *Trends in Cognitive Sciences, 10*(4), 146-151.

Archer, M. (1998). Realism in the social sciences. In M. Archer, R. Bhaskar, A. Collier, T. Lawson & A. Norrie (Eds.), *Critical Realism: Essential Readings* (pp. 189-205). London: Routledge.

Armstrong, F. (1999). Inclusion, curriculum and the struggle for space in school. *International Journal of Inclusive Education, 3*(1), 75-87.

Askew, M., Brown, M., Rhodes, V., Johnson, D., & Wiliam, D. (1997). *Effective teachers of numeracy*. London: King's College London.

Askew, M., Hodgen, J., Hossain, S., & Bretscher, N. (2010). *Values and variables: A review of mathematics education in countries with high mathematics attainment*. London: The Nuffield Foundation.

Askew, M., Millett, A., Brown, M., Rhodes, V., & Bibby, T. (2001). Entitlement to attainment: Tensions in the National Numeracy Strategy. *The Curriculum Journal, 12*(1), 5-28.

Askew, M., & Wiliam, D. (1995). *Recent research in mathematics education 5-16*. London: Ofsted.

Audiger, F., & Motta, D. (1998). The strange concept of affective education: a French perspective. In P. Lang, Y. Katz & I. Menezes (Eds.), *Affective Education: A Comparative View* (pp. 132-144). London: Cassell.

Badger, D., Nursten, J., Williams, P., & Woodward, M. (2000). Should all literature reviews be systematic? *Evaluation and Research in Education, 14*(3&4), 220-230.

Baines, E., Blatchford, P., & Kutnick, P. (2003). Changes in grouping practices over primary and secondary school. *International Journal of Educational Research, 39*(1-2), 9-34.

Ball, S. (1981). *Beachside Comprehensive*. Cambridge: Cambridge University Press.

Ball, S. (1990). Self-doubt and soft data: Social and technical trajectories in ethnographic fieldwork. *Qualitative Studies in Education, 3*(2), 157-171.

Ball, S. (1991). Power, conflict, micropolitics and all that! In G. Walford (Ed.), *Doing educational research* (pp. 166–192). London: Routledge.

Barker Lunn, J. C. (1970). *Streaming in the primary school: A longitudinal study of children in streamed and non-streamed junior schools*. Slough: National Foundation for Educational Research.

Baron-Cohen, S., Wheelwright, S., Burtenshaw, A., & Hobson, E. (2007). Mathematical talent is linked to autism. *Human Nature, 18*(2), 125-131.

Bartholomew, H. (1999). *Setting in stone? How ability grouping practices structure and constrain achievement in mathematics.* Paper presented at the British Educational Research Association Annual Conference, University of Sussex, Brighton.

Bartholomew, H. (2002). *Negotiating identity in the community of the mathematics classroom.* Paper presented at the 3rd International MES Conference, Copenhagen.

Barwell, R. (2005). Ambiguity in the mathematics classroom. *Language and Education, 19*(2), 118-126.

Bauersfeld, H. (1988). Interaction, construction, and knowledge: Alternative perspectives for mathematics education. In D. A. Grouws & T. Cooney (Eds.), *Perspectives on Research on Effective Mathematics Teaching* (Vol. 1, pp. 27-46). Reston, Virginia: Lawrence Erlbaum Associates / National Council of Teachers of Mathematics.

Bazeley, P. (2007). *Qualitative data analysis with NVivo*. London: SAGE.

Bell, J., & Emery, J. (2006). The curious case of the disappearing mathematicians. *Research Matters: A Cambridge Assessment Publication, 2*, 21-23.

Bennett, N., Carré, C., & Dunne, E. (1993). Learning to teach. In N. Bennett & C. Carré (Eds.), *Learning to Teach* (pp. 212-220). London: Routledge.

BERA. (2004). Revised ethical guidelines for educational research (2004) Retrieved 16th January 2006, from http://www.bera.ac.uk/publications/guides.php

Berger, P. & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge.* London: Penguin.

Betts, J., & Shkolnik, J. (2000a). The effects of ability grouping on student achievement and resource allocation in secondary schools. *Economics of Education Review, 19*(1), 1-15.

Betts, J., & Shkolnik, J. (2000b). Key difficulties in identifying the effects of ability grouping on student achievement. *Economics of Education Review, 19*(1), 21-26.

Bew, P. (2011). *Independent review of Key Stage 2 testing, assessment and accountability: Final report*. London: Department for Education.

Bhaskar, R. (1975). *A realist theory of science*. Leeds: Leeds Books Ltd.

Bhaskar, R. (1979). *The possibility of naturalism: A philosophical critique of the contemporary human sciences*. Brighton: Harvester Press.

Bhaskar, R. (1989). *Reclaiming reality: A critical introduction to contemporary philosophy*. London: Verso.

Bhaskar, R. (1993). *Dialectic: The pulse of freedom*. London: Verso.

Bhaskar, R. (1998a). Critical realism and dialectic. In M. Archer, R. Bhaskar, A. Collier, T. Lawson & A. Norrie (Eds.), *Critical Realism: Essential Readings* (pp. 575-640). London: Routledge.

Bhaskar, R. (1998b). Societies. In M. Archer, R. Bhaskar, A. Collier, T. Lawson & A. Norrie (Eds.), *Critical Realism: Essential Readings* (pp. 206-257). London: Routledge.

Bibby, T. (2009). How do children understand themselves as learners? Towards a learner-centred understanding of pedagogy. *Pedagogy, Culture & Society, 17*(1), 41-55.

Bibby, T., Moore, A., Clark, S., & Haddon, A. (2007). *Children's learner-identities in mathematics at Key Stage 2: Final report*. London: Institute of Education.

Bills, L., Cooker, M., Huggins, R., Iannone, P., & Nardi, E. (2006). Promoting mathematics as a field of study: Events and activities for the sixth-form pupils of UEA's Further Mathematics Centre (Final Report of a UEA Teaching Fellowship 2005-2006).

Bishop, A. (1976). Krutetskii on mathematical ability. *Mathematics Teaching, 77*, 31-34.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education, 5*(1), 7-75.

Blatchford, P., Bassett, P., Brown, P., Martin, C., Russell, A., & Webster, R. (2011). The impact of support staff on pupils' 'positive approaches to learning' and their academic progress. *British Educational Research Journal, 37*(3), 443-464.

Blease, D. (1995). Teachers’ judgements of their pupils: Broad categories and multiple criteria. *Educational Studies, 21*(2), 203-215.

Boaler, J. (1997a). *Experiencing school mathematics: Teaching styles, sex and setting*. Buckingham: Open University Press.

Boaler, J. (1997b). Setting, social class and survival of the quickest. *British Educational Research Journal, 23*(5), 575-595.

Boaler, J. (1997c). When even the winners are losers: Evaluating the experiences of 'top set' students. *Journal of Curriculum Studies, 29*(2), 165-182.

Boaler, J. (2000a). Exploring situated insights into research and learning. *Journal for Research in Mathematics Education, 31*(1), 113-119.

Boaler, J. (2000b). Mathematics from another world: Traditional communities & the alienation of learners. *Journal of Mathematical Behavior, 18*(4), 379-397.

Boaler, J. (2005). The 'psychological prisons' from which they never escaped: The role of ability grouping in reproducing social class inequalities. *Forum, 47*(2&3), 135-143.

Boaler, J. (2008). Promoting 'relational equity' and high mathematics achievement through an innovative mixed-ability approach. *British Educational Research Journal, 34*(2), 167-194.

Boaler, J., & Greeno, J. (2000). Identity, agency, and knowing in mathematics worlds. In J. Boaler (Ed.), *Multiple Perspectives on Mathematics Teaching and Learning* (pp. 171-200). Westport, CT: Ablex Publishing.

Boaler, J., Wiliam, D., & Brown, M. (2000). Students' experiences of ability grouping: Disaffection, polarisation and the construction of failure. *British Educational Research Journal, 26*(5), 631-648.

Bonsen, M., Bos, W., & Frey, K. (2008). Germany. In I. Mullis, M. Martin, J. Olson, D. Berger, D. Milne & G. Stanco (Eds.), *TIMSS 2007 Encyclopedia: A guide to mathematics and science education around the world* (Vol. 1, pp. 203-216). Lynch School of Education, Boston College: TIMSS & PIRLS International Study Center.

Booher-Jennings, J. (2005). Below the bubble: “Educational triage” and the Texas accountability system. *American Educational Research Journal, 42*(2), 231.

Brassell, A., Petry, S., & Brooks, D. (1980). Ability grouping, mathematics achievement, and pupil attitudes toward mathematics. *Journal for Research in Mathematics Education, 11*(1), 22-28.

Brewer, D. J. (2000). *Ethnography*. Buckingham: Open University Press.

Broadfoot, P., Osborn, M., Gilly, M., & Paillet, A. (1987). Teachers' conceptions of their professional responsibility: Some international comparisons. *Comparative education, 23*(3), 287-301.

Brown, M., Askew, M., Baker, D., Denvir, H., & Millett, A. (1998). Is the National Numeracy Strategy research-based? *British Journal of Educational Studies, 46*(4), 362-385.

Brown, M., Askew, M., Johnson, D., & Street, B. (1997-2003). Leverhulme Numeracy Research Programme (LNRP) Retrieved 29.01.2007, from http://www.kcl.ac.uk/schools/sspp/education/research/leverhulme.html

Brown, M., Brown, P., & Bibby, T. (2008). "I would rather die": Reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education, 10*(1), 3-18.

Brown, T. (2001). *Mathematics education and language: Interpreting hermeneutics and post-structuralism (Revised 2nd edition)*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Brunello, G., & Checchi, D. (2006). Does school tracking affect equality of opportunity? New international evidence. *IZA Discussion Paper No. 2348*. Bonn, Germany: Forschungsinstitut zur Zukunft der Arbeit (IZA) (Institute for the Study of Labor).

Bryman, A. (2001). *Social research methods*. Oxford: Oxford University Press.

Bryman, A. (2007). Barriers to integrating quantitative and qualitative research. *Journal of Mixed Methods Research, 1*(1), 8-22.

Burawoy, M. (1998). The extended case method. *Sociological Theory, 16*(1), 4-33.

Burgess, R. (1989). Grey areas: Ethical dilemmas in educational ethnography. In R. Burgess (Ed.), *The Ethics of Educational Research* (pp. 60-76). London: RoutledgeFalmer.

Burris, C. C., Heubert, J. P., & Levin, H. M. (2006). Accelerating mathematics achievement using heterogeneous grouping. *American Educational Research Journal, 43*(1), 105-136.

Burton, D. (2000). The use of case studies in social science research. In D. Burton (Ed.), *Research Training for Social Scientists* (pp. 215-225). London: SAGE.

Butterworth, B. (1999). *The mathematical brain*. London: Macmillan.

Buxton, L. (1981). *Do you panic about maths? Coping with maths anxiety*. London: Heinemann.

Cahan, S., Linchevski, L., Ygra, N., & Danziger, I. (1996). The cumulative effect of ability grouping on mathematical achievement: A longitudinal perspective. *Studies in Educational Evaluation, 22*(1), 29-40.

Callahan, R. M. (2005). Tracking and high school English learners: Limiting opportunity to learn. *American Educational Research Journal, 42*(2), 305.

Calvert, M. (2009). From 'pastoral care' to 'care': Meanings and practices. *Pastoral Care in Education, 27*(4), 267-277.

Carbonaro, W. (2005). Tracking, students' effort, and academic achievement. *Sociology of Education, 78*(1), 27-49.

Carr, M. (2001). A sociocultural approach to learning orientation in an early childhood setting. *Qualitative Studies in Education, 14*(4), 525-542.

Carroll, M. (2010). The practice of pastoral care of teachers: A summary analysis of published outlines. *Pastoral Care in Education, 28*(2), 145-154.

Chalmers, A. F. (1999). *What is this thing called Science?* Buckingham: Open University Press.

Chambers, D. W. (1983). Stereotypic images of the scientist: The draw-a-scientist test. *Science Education, 67*(2), 255-265.

Charmaz, K. (2005). Grounded theory in the 21st century: Applications for advancing social justice studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (pp. 507-535). London: SAGE.

Clark, H. (2002). *Building education: The role of the physical environment in enhancing teaching and research*. London: Institute of Education, University of London.

Cobb, P., Wood, T., Yackel, E., & Perlwitz, M. (1992). A follow-up assessment of a second-grade problem-centered mathematics project. *Educational Studies in Mathematics, 23*(5), 483-504.

Cobb, P., Wood, T., Yackel, E., Wheatley, G., Trigatti, B., & Perlwitz, M. (1991). Assessment of a problem-centred second-grade mathematics project. *Journal for Research in Mathematics Education, 22*(1), 3-29.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Should we be using learning styles?: What research has to say to practice. London: Learning and Skills Research Centre.

Collier, A. (1998). Stratified explanation and Marx's conception of history. In M. Archer, R. Bhaskar, A. Collier, T. Lawson & A. Norrie (Eds.), *Critical Realism: Essential Readings* (pp. 258-281). London: Routledge.

Cooper, B. (1984). On explaining change in school subjects. In I. F. Goodson & S. Ball (Eds.), *Defining the Curriculum: Histories and Ethnographies* (pp. 45-63). London: The Falmer Press.

Covington, M. (2000). Goal theory, motivation, and school achievement: An integrative review. *Annual Review of Psychology, 51*(1), 171-200.

Cramer, D. (2003). *Advanced quantitative data analysis*. Maidenhead: Open University Press.

Crooks, T. (1988). The impact of classroom evaluation practices on students. *Review of Educational Research, 58*(4), 438-481.

Cruickshank, J. (2003). Critical realism: A brief definition. In J. Cruickshank (Ed.), *Critical Realism: The Difference that it makes* (pp. 1-14). London: Routledge.

Davies, J., Hallam, S., & Ireson, J. (2003). Ability groupings in the primary school: Issues arising from practice. *Research Papers in Education, 18*(1), 45-60.

Deetz, S., Newton, T., & Reed, M. (2007). Special issue on 'Responses to social constructionism and critical realism in organizational studies'. *Organizational Studies, 28*(3), 429-430.

Denicolo, P. (2003). Elicitation methods to fit different purposes. In F. Fransella (Ed.), *International Handbook of Personal Construct Psychology* (pp. 123-131). Chichester: John Wiley & Sons.

Denvir, B., & Brown, M. (1986a). Understanding of number concepts in low attaining 7-9 year olds: Part 1: Development of descriptive framework and diagnostic instrument. *Educational Studies in Mathematics, 17*(1), 15-36.

Denvir, B., & Brown, M. (1986b). Understanding of number concepts in low attaining 7-9 year olds: Part 2: The teaching studies. *Educational Studies in Mathematics, 17*(2), 143-164.

Denvir, B., & Brown, M. (1987). The feasibility of class administered diagnostic assessment in primary mathematics. *Educational Research, 29*(2), 95-107.

Denzin, N. K. (1997). Triangulation in educational research. In J. Keeves (Ed.), *Educational Research, Methodology, and Measurement: An International Handbook* (2nd ed., pp. 318-322). Oxford: Elsevier Science.

Department for Education. (2008). Achievement and attainment tables 2008 Retrieved 29/05/2011, from http://www.education.gov.uk/performancetables/primary_08.shtml

Deppeler, J., Ashman, A., Conway, R., Jones, P., O'Gorman, E., García-Cedillo, I., . . . Fletcher, T. (2010). *Collaboration in teacher professional learning: Universities, school-systems, schools and teachers.* Paper presented at the Inclusive and Supportive Education Congress, Queen's University, Belfast, 2-5th August 2010.

Devi, A. (2010). Dual exceptionality. *Special* (May 2010), 25-27.

DfEE. (1997). *Excellence in schools*. London: HMSO.

DfES. (2005). *Higher standards, better schools for all: More choice for parents and pupils*. Education White Paper, October 2005, London: Department for Education and Skills.

DfES. (2006). *Grouping pupils for success*. London: Department for Education and Skills.

Dixon, A. (2002). Editorial. *Forum, 44*(1), 1.

Dixon, A. (2004). Space, schools and the younger child. *Forum, 46*(1), 19-23.

Dorman, J. (2002). Classroom environment research: Progress and possibilities. *Queensland Journal of Educational Research, 18*(2), 112-140.

Dowling, P. (1998). *The sociology of mathematics education: Mathematical myths/pedagogic texts*. London: The Falmer Press.

Doyle, W., & Carter, K. (1984). Academic tasks in classrooms. *Curriculum Inquiry, 14*(2), 129-149.

Duda, J. L., & Nicholls, J. (1992). Dimensions of achievement motivation in schoolwork and sport. *Journal of Educational Psychology, 84*(3), 290-299.

Durbin, B., & Yeshanew, T. (2010). *BSF school report: B+ for attendance but C- for attainment*. Slough: NfER.

Dweck, C. (2000). *Self-theories: Their role in motivation, personality, and development*. Philadelphia, PA: Psychology Press.

Dweck, C., & Master, A. (2008). Self-theories motivate self-regulated learning. In D. Schunk & B. Zimmerman (Eds.), *Motivation and Self-Regulated Learning: Theory, Research, and Applications* (pp. 31-51). London: Routledge.

Economic and Social Research Council. (2005). *Research ethics framework (REF)*. Swindon: Economic and Social Research Council.

Eder, D. (1981). Ability grouping as a self-fulfilling prophecy: A micro-analysis of teacher-student interaction. *Sociology of Education, 54*(3), 151-162.

Ely, M., Vinz, R., Downing, M., & Anzul, M. (1997). *On writing qualitative research: Living by words*. London: The Falmer Press.

EPPI-Centre. (2006). *EPPI-Centre methods for conducting systematic reviews*. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Esposito, D. (1973). Homogeneous and heterogeneous ability grouping: Principal findings and implications for evaluating and designing more effective educational environments. *Review of Educational Research, 43*(2), 163-179.

European Agency for Development in Special Needs Education. (2009). Multicultural diversity and special needs education. Odense, Denmark: European Agency for Development in Special Needs Education.

Evans, D. (2010). *Early numeracy development: Implications for preventing numeracy difficulties.* Paper presented at the Inclusive and Supportive Education Congress, Queen's University, Belfast, 2-5th August 2010.

Felmlee, D., & Eder, D. (1983). Contextual effects in the classroom: The impact of ability groups on student attention. *Sociology of Education, 56*(2), 77-87.

Ferguson, G. A. (1954). On learning and human ability. *Canadian Journal of Psychology, 8*(2), 95-112.

Field, A. (2005). *Discovering Statistics Using SPSS* (2nd ed.). London: Sage.

Filer, A., & Pollard, A. (2000). *The social world of pupil assessment: Processes and contexts of primary schooling*. London: Continuum.

Finley, M. K. (1984). Teachers and tracking in a comprehensive high school. *Sociology of Education, 57*(4), 233-243.

Fisher, K. (2004). Revoicing classrooms: A spatial manifesto. *Forum, 46*(1), 36-38.

Forgasz, H. (2010). Streaming for mathematics in years 7-10 in Victoria: An issue of equity? *Mathematics Education Research Journal, 22*(1), 34.

Forrester, G. (2005). All in a day's work: Primary teachers 'performing' and 'caring'. *Gender and Education, 17*(3), 271-287.

Fuchs, L., Fuchs, D., Hamlett, C., & Karns, K. (1998). High-achieving students' interactions and performance on complex mathematical tasks as a function of homogeneous and heterogeneous pairings. *American Educational Research Journal, 35*(2), 227-267.

Fuligni, A., Eccles, J., & Barber, B. (1995). The long-term effects of seventh-grade ability grouping in mathematics. *Journal of Early Adolescence, 15*(1), 58-89.

Galton, F. (1869/1978). *Hereditary genius*. London: Julian Friedmann Publishers.

Gamoran, A. (2004). Classroom organization and instructional quality. In H. Walberg, A. Reynolds & M. Wang (Eds.), *Can Unlike Students Learn Together? Grade Retention, Tracking, and Grouping* (pp. 141-155). Greenwich, Connecticut: Information Age Publishing.

Gamoran, A., & Berends, M. (1987). The effects of stratification in secondary schools: Synthesis of survey and ethnographic research. *Review of Educational Research, 57*(4), 415-435.

Gardner, J. (2006). *Assessment and learning*. London: SAGE.

Gates, P. (2006). Going beyond belief systems: Exploring a model for the social influence on mathematics teacher beliefs. *Educational Studies in Mathematics, 63*(3), 347-369.

Geake, J. (2008). Neuromythologies in education. *Educational Research, 50*(2), 123-133.

Gee, J. P. (1999). *An introduction to discourse analysis*. London: Routledge.

Gee, J. P. (2001). Identity as an analytic lens for research in education. In W. Secada (Ed.), *Review of Research in Education* (Vol. 25, pp. 99-125). Washington, DC: American Educational Research Association.

Gee, J. P. (2008). *Social linguistics and literacies: Ideology in discourses* (3rd ed.). London: Routledge.

Gillborn, D., & Youdell, D. (2000). *Rationing education: Policy, practice, reform and equality*. Buckingham: Open University Press.

Goodson, I. F. (1993). *School subjects and curriculum change*. London: The Falmer Press.

Goodson, I. F., & Managan, J. M. (1995). Subject cultures and the introduction of classroom computers. *British Educational Research Journal, 25*(5), 613-628.

Goodson, I. F., & Marsh, C. J. (1996). *Studying school subjects: A guide*. London: The Falmer Press.

Goswami, U. (2006). Neuroscience and education: From research to practice. *Nature Reviews Neuroscience, 7*, 2-7.

Gove, M. (2007). It's time for modern compassionate Conservative education policy. *Speech to the Conservative Party conference* Retrieved 12/02/2011, from http://www.conservatives.com/News/Speeches/2007/10/Michael_Gove_Its_time_for_modern_compassionate_Conservative_education_policy.aspx

Gray, E. (1991). An analysis of diverging approaches to simple arithmetic: Preference and its consequences. *Educational Studies in Mathematics, 22*(6), 551-574.

Gray, E., & Tall, D. (1994). Duality, ambiguity, and flexibility: A "proceptual" view of simple arithmetic. *Journal for Research in Mathematics Education, 25*(2), 116-140.

Haladyna, T., Shaughnessy, J., & Shaughnessy, J. M. (1983). A causal analysis of attitude toward mathematics. *Journal for Research in Mathematics Education, 14*(1), 19-29.

Hall, K., Collins, J., Benjamin, S., Nind, M., & Sheehy, K. (2004). SATurated models of pupildom: Assessment and inclusion/exclusion. *British Educational Research Journal, 30*(6), 801-817.

Hallam, S. (2002). *Ability grouping in schools: A literature review*. London: Institute of Education.

Hallam, S. (2011). *Streaming in UK primary schools: Evidence from the Millennium Cohort Study.* Paper presented at the British Educational Research Association Annual Conference, Institute of Education, London, 6th - 8th September.

Hallam, S., & Deathe, K. (2002). Ability grouping: Year group differences in self-concept and attitudes of secondary school pupils. *Westminister Studies in Education, 25*(1), 7-17.

Hallam, S., & Ireson, J. (2005). Secondary school teacher's pedagogic practices when teaching mixed and structured ability classes. *Research Papers in Education, 20*(1), 3-24.

Hallam, S., & Ireson, J. (2006). Secondary school pupils' preferences for different types of structured grouping practices. *British Educational Research Journal, 32*(4), 583-599.

Hallam, S., Ireson, J., & Davies, J. (2004a). Grouping practices in the primary school: what influences change? *British Educational Research Journal, 30*(1), 117-140.

Hallam, S., Ireson, J., & Davies, J. (2004b). Primary pupils' experiences of different types of grouping in school. *British Educational Research Journal, 30*(4), 515-533.

Hallam, S., Ireson, J., Lister, V., Chaudhury, I., & Davies, J. (2003). Ability grouping practices in the primary school: A survey. *Educational Studies, 29*(1), 69-83.

Hallam, S., & Toutounji, I. (1996). *What do we know about the grouping of pupils by ability?: A research review*. London: Institute of Education, University of London.

Hallinan, M., & Sørensen, A. B. (1987). Ability grouping and sex differences in mathematics achievement. *Sociology of Education, 60*(2), 63-72.

Hamilton, L. (2002). Constructing pupil identity: Personhood and ability. *British Educational Research Journal, 28*(4), 591-602.

Hamilton, L., & O'Hara, P. (2011). The tyranny of setting (ability grouping): Challenges to inclusion in Scottish primary schools. *Teaching and Teacher Education, 27*(4), 712-721.

Hammersley, M., & Atkinson, P. (1983). *Ethnography: Principles in practice*. London: Routledge.

Harlen, W. (2004a). A systematic review of the evidence of reliability and validity of assessment by teachers used for summative purposes *(Research Evidence in Education Library)*. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Harlen, W. (2004b). A systematic review of the evidence of the impact on students, teachers and the curriculum of the process of using assessment by teachers for summative purposes *(Research Evidence in Education Library)*. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Harlen, W., & Malcolm, H. (1999). *Setting and streaming: A research review*. Edinburgh: The Scottish Council for Research in Education.

Hart, L., Smith, S., Swars, S., & Smith, M. (2009). An examination of research methods in mathematics education (1995-2005). *Journal of Mixed Methods Research, 3*(1), 26-41.

Hart, S. (1998). A sorry tail: Ability, pedagogy and educational reform. *British Journal of Educational Studies, 46*(2), 153-168.

Hart, S., Dixon, A., Drummond, M. J., & McIntyre, D. (2004). *Learning without limits*. Maidenhead: Open University Press.

Haworth, C., Asbury, K., Dale, P., & Plomin, R. (2011). Added value measures in education show genetic as well as environmental influence. *Plos One, 6*(2), 1-10.

Henerson, M., Morris, L., & Fitz-Gibbon, C. (1987). *How to measure attitudes*. London: SAGE.

Heyman, G., Gee, C., & Giles, J. (2003). Preschool children's reasoning about ability. *Child Development, 74*(2), 516-534.

Hobbs, G., & Vignoles, A. (2010). Is children's free school meal 'eligibility' a good proxy for family income? *British Educational Research Journal, 36*(4), 673-690.

Hodgen, J. (2007). Setting, streaming and mixed ability teaching. In J. Dillon & M. Maguire (Eds.), *Becoming a Teacher* (3rd ed., pp. 201-212). Maidenhead: Open University Press.

Hodgen, J., & Marks, R. (2009). Mathematical 'ability' and identity: A sociocultural perspective on assessment and selection. In L. Black, H. Mendick & Y. Solomon (Eds.), *Mathematical Relationships in Education: Identities and Participation* (pp. 31-42). Abingdon: Routledge.

Holland, D., Skinner, D., Lachicotte Jr, W., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, Massacheusetts: Harvard University Press.

Houssart, J. (2004). *Low attainers in primary mathematics: The whisperers and the maths fairy*. London: RoutledgeFalmer.

Howe, M. (1996). Concepts of ability. In I. Dennis & P. Tapsfield (Eds.), *Human Abilities: Their Nature and Measurement* (pp. 39-48). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Howe, M. (1997). *IQ in question: The truth about intelligence*. London: SAGE.

Hoyles, C. (1980). *Factors in school learning - the pupils' view. A study with particular reference to mathematics.*, *Unpublished PhD Thesis,* Centre for Science Education, Chelsea College, University of London, UK.

Human Genome Project. (1990-2003). Human genome project information Retrieved 14.12.07, from http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml

Iphofen, R. (2009). *Ethical decision-making in social research: A practical guide*. Basingstoke: Palgrave Macmillan.

Ipsos MORI. (2010). *Young people omnibus 2010 (wave 16): A research study among 11-16 year olds on behalf of the Sutton Trust*. London: Sutton Trust.

Ireson, J., Clark, H., & Hallam, S. (2002). Constructing ability groups in the secondary school: Issues in practice. *School Leadership & Management, 22*(2), 163-176.

Ireson, J., & Hallam, S. (1999). Raising standards: Is ability grouping the answer? *Oxford Review of Education, 25*(3), 343-358.

Ireson, J., & Hallam, S. (2001). *Ability grouping in education*. London: SAGE.

Ireson, J., & Hallam, S. (2003). Ability grouping in schools: Does it matter? *The Psychology of Education Review, 27*(1), 3-7.

Ireson, J., Hallam, S., Hack, S., Clark, H., & Plewis, I. (2002). Ability grouping in English secondary schools: Effects on attainment in English, mathematics and science. *Educational Research and Evaluation, 8*(3), 299-318.

Ireson, J., Hallam, S., & Hurley, C. (2005). What are the effects of ability grouping on GCSE attainment? *British Educational Research Journal, 31*(4), 443-458.

Jackson, B. (1964). *Streaming: An educational system in miniature*. London: Routledge & Kegan Paul.

Jackson, P. (2000). Writing up qualitative data. In D. Burton (Ed.), *Research Training for Social Scientists* (pp. 244-252). London: SAGE.

Jaworski, B. (1998). The centrality of the researcher: Rigor in a constructivist inquiry into mathematics teaching. In A. Teppo (Ed.), *Qualitative Research Methods in Mathematics Education* (pp. 112-127). Reston, Virginia: The National Council of Teachers of Mathematics (NCTM).

Kaplan, A., & Midgley, C. (1997). The effect of achievement goals: Does level of perceived academic competence make a difference? *Contemporary Educational Psychology, 22*(4), 415-435.

Keene, L. (2008). United States. In I. Mullis, M. Martin, J. Olson, D. Berger, D. Milne & G. Stanco (Eds.), *TIMSS 2007 Encyclopedia: A guide to mathematics and science education around the world* (Vol. 2, pp. 621-634). TIMSS & PIRLS International Study Center: Lynch School of Education, Boston College.

Kelly, G. (1955). *The psychology of personal constructs – volume one: A theory of personality*. New York: W. W. Norton & Company Inc.

Kelly, G. (2003). A brief introduction to personal construct theory. In F. Fransella (Ed.), *International Handbook of Personal Construct Psychology* (pp. 1-20). Chichester: John Wiley & Sons.

Kelly, S. (2004). Are teachers tracked? On what basis and with what consequences. *Social Psychology of Education, 7*(1), 55-72.

Kelly, S. (2009). Tracking teachers. In L. J. Saha & A. G. Dworkin (Eds.), *International Handbook of Research on Teachers and Teaching, Part One* (Vol. 21, pp. 451 - 461). New York: Springer.

Kidd, H. (2004). *Secondary mathematics teachers' figured worlds and identities: Stability and fluidity. Unpublished PhD Thesis,* King's College, University of London.

Kifer, E. (1992). Opportunities, talents and participation. In L. Burstein (Ed.), *The IEA Study of Mathematics III: Student Growth and Classroom Processes* (pp. 279-307). Oxford: Pergamon Press Ltd.

Kirshner, D. (2002). Untangling teachers' diverse aspirations for student learning: A crossdisciplinary strategy for relating psychological theory to pedagogical practice. *Journal for Research in Mathematics Education, 33*(1), 46-58.

Kline, P. (1990). Selecting the best test. In J. Beech & L. Harding (Eds.), *Testing People: A Practical Guide to Psychometrics* (pp. 107-118). Windsor: NFER-NELSON Publishing Company.

Kline, P. (2000). *Handbook of psychological testing* (2nd ed.). London: Routledge.

Kovas, Y., Harlaar, N., Petrill, S. A., & Plomin, R. (2005). 'Generalist genes' and mathematics in 7-year-old twins. *Intelligence, 33*(5), 473-489.

Kowalczyk, R., Sayer, A., & New, C. (2000). *Critical realism: What difference does it make?* Paper presented at the Fourth Annual IACR International Conference, The University of Lancaster, UK.

Krutetskii, V. A. (1976). *The psychology of mathematical abilities in schoolchildren* (J. Teller, Trans.). Chicago: The University of Chicago Press.

Kulik, C., & Kulik, J. (1982a). Effects of ability grouping on secondary school students: A meta-analysis of evaluation findings. *American Educational Research Journal, 19*(3), 415-428.

Kulik, C., & Kulik, J. (1982b). Research synthesis on ability grouping. *Educational Leadership, 39*(8), 619-621.

Kulik, J. (2004). Grouping, tracking, and de-tracking: Conclusions from experimental, correlational, and ethnographic research. In H. Walberg, A. Reynolds & M. Wang (Eds.), *Can Unlike Students Learn Together? Grade Retention, Tracking, and Grouping* (pp. 157-182). Greenwich, Connecticut: Information Age Publishing.

Kurasaki, K. S. (2000). Intercoder reliability for validating conclusions drawn from open-ended interview data. *Field Methods, 12*(3), 179-194.

Kutnick, P., Blatchford, P., & Baines, E. (2002). Pupil groupings in primary school classrooms: Sites for learning and social pedagogy. *British Educational Research Journal, 28*(2), 187-206.

Kutnick, P., Hodgkinson, S., Sebba, J., Humphreys, S., Galton, M., Steward, S., . . . Baines, E. (2006). *Pupil grouping strategies and practices at Key Stage 2 and 3: Case studies of 24 schools in England*. Brighton: University of Brighton.

Kutnick, P., Sebba, J., Blatchford, P., Galton, M., Thorp, J., Macintyre, H., & Berdondini, L. (2005). *The effects of pupil grouping: Literature review. DfES Research Report RR688*. Nottingham: Department for Education and Skills (DfES).

Kvale, S. (1996). *InterViews: An introduction to qualitative research interviewing*. London: SAGE.

Kwok, D. C., & Lytton, H. (1996). Perceptions of mathematics ability versus actual mathematics performance: Canadian and Hong Kong Chinese children. *British Journal of Educational Psychology, 66*(2), 209-222.

Laclau, E., & Bhaskar, R. (1998). Discourse theory vs critical realism. *Journal of Critical Realism, 1*(2), 9-14.

Leder, G., & Forgasz, H. (2006). Affect and mathematics education: PME perspectives. In A. Gutiérrez & P. Boero (Eds.), *Handbook of Research on the Psychology of Mathematics Education: Past, Present and Future* (pp. 403-427). Rotterdam: Sense Publishers.

Lerman, S. (2009). Pedagogy, discourse, and identity. In L. Black, H. Mendick & Y. Solomon (Eds.), *Mathematical Relationships in Education: Identities and Participation* (pp. 147-155). Abingdon: Routledge.

Leung, C. (2005). Mathematical vocabulary: Fixers of knowledge or points of exploration? *Language and Education, 19*(2), 127-135.

Linchevski, L., & Kutscher, B. (1998). Tell me with whom you're learning, and I'll tell you how much you've learned: Mixed-ability versus same-ability grouping in mathematics. *Journal for Research in Mathematics Education, 29*(5), 533-554.

Livne, N., Livne, O., & Milgram, R. (1999). Assessing academic and creative abilities in mathematics at four levels of understanding. *International Journal of Mathematics, Education, Science and Technology, 30*(2), 227-242.

Lotan, R. (1997). Complex instruction: An overview. In E. Cohen & R. Lotan (Eds.), *Working for equity in heterogeneous classrooms: Sociological theory in practice* (pp. 15-27). New York: Teachers College Press.

Lou, Y., Abrami, P., Spence, J., Poulsen, C., Chambers, B., & d'Apollonia, S. (1996). Within-class grouping: A meta-analysis. *Review of Educational Research, 66*(4), 423-458.

Lupart, J., & Toy, R. (2009). Twice-exceptional: Multiple pathways to success. In L. Shavinina (Ed.), *International Handbook on Giftedness* (3rd ed., pp. 507-525). Heidelberg: Springer.

Ma, X. (2002). Early acceleration of mathematics students and its effect on growth in self-esteem: A longitudinal study. *International Review of Education, 48*(6), 443-468.

Macintyre, H., & Ireson, J. (2002). Within-class ability grouping: Placement of pupils in groups and self-concept. *British Educational Research Journal, 28*(2), 249-263.

Malmivuori, M.-L. (2006). Affect and self-regulation. *Educational Studies in Mathematics, 63*(2), 149-164.

Marks, R. (2005). *Challenging the 'truth' of 'ability': Policy interpretation and discourse in primary numeracy. Unpublished MA Dissertation*. King's College, London. UK.

Marks, R. (2006). *Investigating discourses of ability in primary school mathematics: Using a case-study to explore the methodological implications of research. Unpublished M.Res Pilot Study*. King's College, London. UK.

Marks, R. (2007). *"They ain't like us": Constructions of ability in primary school mathematics.* Paper presented at the Mathematics Interest Group, King's College, London, November 2007.

Marsh, H. W. (1987). The big-fish-little-pond effect on academic self-concept. *Journal of educational psychology, 79*(3), 280–295.

Marsh, H. W. (2007). *Self-concept theory, measurement & research into policy-practice: A methodological-substantive synergy*. Paper presented at the Keynote Address to the British Educational Research Association Annual Conference, Institute of Education, London, *5th-8th September 2007*.

Mason, D. A. (1995). Grouping students for elementary school mathematics: A survey of principals in 12 states. *Educational Research and Evaluation, 1*(4), 318-346.

Mason, D. A., & Good, T. (1993). Effects of two-group and whole-class teaching on regrouped elementary students' mathematics achievement. *American Educational Research Journal, 30*(2), 328-360.

Maton, K. (2001). The critical and real need of educational research for critical realism. *Journal of Critical Realism (incorporating Alethia), 4*(1), 56-59.

Maton, K., & Shipway, B. (2007). Studies of education. In M. Hartwig (Ed.), *Dictionary of Critical Realism* (pp. 442-443). Abingdon: Routledge.

Matthews, A., & Pepper, D. (2005). *Evaluation of participation in A level mathematics: Interim report*. London: Qualifications and Curriculum Agency.

McGregor, J. (2004). Space, power and the classroom. *Forum, 46*(1), 13-18.

McLellan, R. (2004). *Motivational goal theory as a possible explanatory framework for differential effects of a lower secondary school cognitive intervention programme.* PhD, *Unpublished PhD Thesis,* King's College, University of London, UK.

McLeod, D. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning* (pp. 575-596). New York: Macmillan.

McPake, J., Harlen, W., Powney, J., & Davidson, J. (1999). *Case studies of setting in primary school classrooms: An extension to the teachers' and pupils' days in the primary classroom project*. Glasgow: The Scottish Council for Research in Education.

Measor, L., & Woods, P. (1984). *Changing schools: Pupil perspectives on transfer to a comprehensive*. Milton Keynes: Open University Press.

Meece, J., Blumenfeld, P., & Hoyle, R. (1988). Students' goal orientations and cognitive engagement in classroom activities. *Journal of Educational Psychology, 80*(4), 514-523.

Meelissen, M. (2008). The Netherlands. In I. Mullis, M. Martin, J. Olson, D. Berger, D. Milne & G. Stanco (Eds.), *TIMSS 2007 Encyclopedia: A guide to mathematics and science education around the world* (Vol. 2, pp. 415-425). TIMSS & PIRLS International Study Center: Lynch School of Education, Boston College.

Mehan, H., & Hubbard, L. (1999). Tracking Untracking: Evaluating the Effectiveness of an Educational Innovation, Center for Research on Education, Diversity and Excellence. Retrieved 15th August, 2011, from http://escholarship.org/uc/item/0xc7h2sg

Meijnen, G. W., & Guldemond, H. (2002). Grouping in primary schools and reference processes. *Educational Research and Evaluation, 8*(3), 229-248.

Mendick, H. (2006). *Masculinities in mathematics*. Maidenhead: Open University Press.

Mendick, H., & Moreau, M.-P. (2007). *Looking for mathematics.* Paper presented at the British Society for Research into Learning Mathematics, London South Bank University, *3rd March 2007*.

Middleton, J. A., & Spanias, P. A. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education, 30*(1), 65-88.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: SAGE.

Millett, A., & Bibby, T. (2004). The context for change: A model for discussion. In A. Millett, M. Brown & M. Askew (Eds.), *Primary Mathematics and the Developing Professional* (pp. 1-18). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Montgomery, D. (2009). Gifted and talented children with special educational needs: Underachievement in dual and multiple exceptionality. In D. Montgomery (Ed.), *Able, Gifted and Talented Underachievers* (2nd ed., pp. 265-301). Chichester: Wiley-Blackwell.

Moore, A. (2006). Recognising desire: A psychosocial approach to understanding education policy implementation and effect. *Oxford Review of Education, 32*(4), 487-503.

Moore, R. (2000). For knowledge: Tradition, progressivism and progress in education - reconstructing the curriculum debate. *Cambridge Journal of Education, 30*(1), 17-36.

Moreau, M.-P., Mendick, H., & Epstein, D. (2007). *Gendered, 'raced' and classed: Construction of mathematicians in popular culture.* Paper presented at the Gender and Education Conference, Trinity College, Dublin, *March 2007*.

Morgan, C. (2005). Words, definitions and concepts in discourses of mathematics, teaching and learning. *Language and Education, 19*(2), 103-117.

Mousley, J. A. (1998). Ability grouping: Some implications for building mathematical understanding. In C. Kanes, M. Goos & E. Warren (Eds.), *Teaching mathematics in new times: proceedings of the Twenty First Annual Conference of the Mathematics Education Research Group of Australasia Incorporated, Gold Coast, Australia, 5th -*

8th July 1998 (Vol. 2, pp. 388-396). Brisbane: Mathematics Education Research Group of Australasia.

Muijs, D., & Dunne, M. (2010). Setting by ability - or is it? A quantitative study of determinants of set placement in English secondary schools. *Educational Research, 52*(4).

Muijs, D., & Dyson, A. (2007). *Setting by ability - Or is it?* Paper presented at the Annual Conference of the British Educational Research Association, Institute of Education, London, 5th-8th September, 2007.

Mulkey, L., Catsambis, S., Carr Steelman, L., & Crain, R. (2005). The long-term effects of ability grouping in mathematics: A national investigation. *Social Psychology of Education, 8*(2), 137-177.

Nardi, E., & Steward, S. (2003). Is mathematics T.I.R.E.D? A profile of quiet disaffection in the secondary mathematics classroom. *British Educational Research Journal, 29*(3), 345-367.

Nash, R. (2005). Explanation and quantification in educational research: The arguments of critical and scientific realism. *British Educational Research Journal, 31*(2), 185-204.

Newton, P. E. (2007). Clarifying the purposes of educational assessment. *Assessment in Education, 14*(2), 149-170.

Nicholls, J. (1989). *The competitive ethos and democratic education*. Cambridge, MA: Harvard University Press.

Nicholls, J., Cheung, P. C., Lauer, J., & Patashnick, M. (1989). Individual differences in academic motivation: Perceived ability, goals, beliefs, and values. *Learning and Individual Differences, 1*(1), 63-84.

Nicholls, J., Cobb, P., Wood, T., Yackel, E., & Patashnick, M. (1990). Assessing students' theories of success in mathematics: Individual and classroom differences. *Journal for Research in Mathematics Education, 21*(2), 109-122.

Nicholls, J., Patashnick, M., & Nolen, S. B. (1985). Adolescents' theories of education. *Journal of Educational Psychology, 77*(6), 683-692.

Noddings, N. (2003). *Caring: A feminine approach to ethics and moral education* (2nd ed.). Berkeley: University of California Press.

Norris, C., & Aleixo, P. (2003). Ability grouping in schools: Attainment and self-esteem. *Education and Health, 21*(4), 59-63.

Oakes, J. (1982). The reproduction of inequity: The content of secondary school tracking. *The Urban Review, 14*(2), 107-120.

Oakes, J. (1992). Can tracking research inform practice?: Technical, normative, and political considerations. *Educational Researcher, 21*(4), 12-21.

Ofsted. (1998). *Setting in primary schools*. London: Office for Standards in Education.

Oliver, B., Harlaar, N., Hayiou Thomas, M. E., Kovas, Y., Walker, S. O., Petrill, S. A., . . . Plomin, R. (2004). A twin study of teacher-reported mathematics performance and low performance in 7-year-olds. *Journal of Educational Psychology, 96*(3), 504-517.

Oliver, C. (2011). Critical realist grounded theory: A new approach for social work research. *To be published in British Journal of Social Work*.

Op't Eynde, P., De Corte, E., & Verschaffel, L. (2002). Framing students' mathematics-related beliefs: A quest for conceptual clarity and a comprehensive categorization. In G. Leder, E. Pehkonen & G. Törner (Eds.), *Beliefs: A Hidden Variable in Mathematics Education?* (pp. 13-37). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Op't Eynde, P., De Corte, E., & Verschaffel, L. (2006). "Accepting emotional complexity": A socioconstructivist perspective on the role of emotions in the mathematics classroom. *Educational Studies in Mathematics, 63*(2), 193-207.

Osborn, M. (2001). Constants and contexts in pupil experience of learning and schooling: Comparing learners in England, France and Denmark. *Comparative Education, 37*(3), 267-278.

Osborn, M., McNess, E., Broadfoot, P., Pollard, A., & Triggs, P. (2000). *What teachers do: Changing policy and practice in primary education*. London: Continuum.

Paechter, C., Edwards, R., Harrison, R., & Twining, P. (2001). Introduction. In C. Paechter, D. Edwards, R. Harrison & P. Twining (Eds.), *Learning, Space and Identity* (pp. 1-6). London: SAGE.

Peacock, A. (2006). Escaping from the bottom set: Finding a voice for school improvement. *Improving Schools, 9*(3), 251.

Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester Jr (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning: a project of the National Council of Teachers of Mathematics* (Vol. 1, pp. 257-315). Charlotte, NC: Information Age Publishing.

Picker, S., & Berry, S. (2000). Investigating pupils' images of mathematicians. *Educational Studies in Mathematics, 43*(1), 65-94.

Pickering, S., & Howard-Jones, P. (2007). Educators' views on the role of neuroscience in education: Findings from a study of UK and international perspectives. *Mind, Brain, and Education, 1*(3), 109-113.

Plomin, R., & Kovas, Y. (2005). Generalist genes and learning disabilities. *Psychological Bulletin, 131*(4), 592-617.

Plomin, R., Kovas, Y., & Haworth, C. (2007). Generalist genes: Genetic links between brain, mind and education. *Mind, Brain, and Education, 1*(1), 11-19.

Plowden, B. H. (1967). *Children and their primary schools - A report to the Central Advisory Council for England*. London: HMSO.

Pollard, A., Triggs, P., Broadfoot, P., McNess, E., & Osborn, M. (2000). *What pupils say: Changing policy and practice in primary education*. London: Continuum.

Porter, S. (2002). Critical realist ethnography. In T. May (Ed.), *Qualitative Research in Action* (pp. 53-72). London: SAGE.

Povey, H. (2010). Teaching for equity, teaching for mathematical engagement. *Philosophy of mathematics education journal, 25, accessed from http://people.exeter.ac.uk/PErnest/pome25/index.html, 04/11/2010*.

Pryor, J., & Torrance, H. (2000). Questioning the three bears: The social construction of classroom assessment. In A. Filer (Ed.), *Assessment: Social Practice and Social Product* (pp. 110-128). London: RoutledgeFalmer.

Pye, J. (1988). *Invisible children: Who are the real losers at school?* Oxford: Oxford University Press.

QCA. (2007). Evaluation of participation in GCE mathematics, Final Report, November 2007: Qualifications and Curriculum Authority.

Räty, H., Kasanen, K., & Snellman, L. (2002). What makes one able? The formation of pupils' conceptions of academic ability. *International Journal of Early Years Education, 10*(2), 121-135.

Reay, D., & Wiliam, D. (1999). 'I'll be a nothing': Structure, agency and the construction of identity through assessment. *British Educational Research Journal, 25*(3), 343-354.

Reuman, D. (1989). How social comparison mediates the relation between ability-grouping practices and students' achievement expectancies in mathematics. *Journal of Educational Psychology, 81*(2), 178-189.

Revill, J. (2005). Twins hold key to unravelling maths gene, *The Observer, 7th August, 2005*.

Reynolds, D., & Muijs, D. (1999). The effective teaching of mathematics: A review of research. *School Leadership & Management, 19*(3), 273-288.

Rist, R. (2000). HER classic reprint-student social class and teacher expectations: The self-fulfilling prophecy in ghetto education. *Harvard Educational Review, 70*(3), 257-302.

Rosenthal, R., & Jacobson, L. (1992). *Pygmalion in the classroom: Teacher expectation and pupils' intellectual development*. Bancyfelin, Carmarthen: Crown House Publishing.

Rowan, B., & Miracle Jr, A. (1983). Systems of ability grouping and the stratification of achievement in elementary schools. *Sociology of Education, 56*(3), 133-144.

Rubin, B., & Noguera, P. (2004). Tracking detracking: Sorting through the dilemmas and possibilities of detracking in practice. *Equity & Excellence in Education, 37*(1), 92-101.

Ruthven, K. (1987). Ability stereotyping in mathematics. *Educational Studies in Mathematics, 18*(3), 243-253.

Ruthven, K. (2011). Using international study series and meta-analytic research syntheses to scope pedagogical development aimed at improving student attitude and achievement in school mathematics and science. *International Journal of Science and Mathematics Education, 9*(2), 419-458.

Sayer, A. (2000). *Realism and social science*. London: SAGE.

Schwartz, F. (1981). Supporting or subverting learning: peer groups patterns in four tracked schools. *Anthropology and Education Quarterley, 12*(2), 99-121.

Scott, D. (2001). Situated views of learning. In C. Paechter, R. Edwards, R. Harrison & P. Twining (Eds.), *Learning, Space and Identity* (pp. 31-41). London: SAGE.

Scott, D. (2005). Critical realism and empirical research methods in education. *Journal of Philosophy of Education, 39*(4), 633-646.

Seaton, M., Marsh, H., & Craven, R. (2010). Big-fish-little-pond effect: Generalizability and moderation - two sides of the same coin. *American Educational Research Journal, 47*(2), 390.

Seeger, F. (1998). Representations in the mathematics classroom: Reflections and constructions. In F. Seeger, J. Voigt & U. Waschescio (Eds.), *The Culture of the Mathematics Classroom* (pp. 308-343). Cambridge: Cambridge University Press.

Seeger, F. (2001). Research on discourse in the mathematics classroom: A commentary. *Educational Studies in Mathematics, 46*(1-3), 287-297.

Sfard, A., Forman, E., & Kieran, C. (2001). Learning discourse: Sociocultural approaches to research in mathematics education. *Educational Studies in Mathematics, 46*(1-3), 1-12.

Shenk, D. (2010). *The genius in all of us: Why everything you've been told about genetics, talent and intelligence is wrong*. London: Icon Books.

Shipway, B. (2002). *Implications of a critical realist perspective in education. Unpublished PhD Thesis,* Southern Cross University, Australia.

Silverman, D. (2005). *Doing qualitative research* (2nd ed.). London: SAGE.

Simons, H. (1989). Ethics of case study in educational research and evaluation. In R. Burgess (Ed.), *The Ethics of Educational Research* (pp. 114-138). London: RoutledgeFalmer.

Slavin, R. (1986). *Ability grouping and student achievement in elementary schools: A best-evidence synthesis (Technical Report No. 1)*. Baltimore, MD: The Johns Hopkins University, Center for Research on Elementary and Middle Schools.

Slavin, R. (1987). Ability grouping and student achievement in elementary schools: A best-evidence synthesis. *Review of Educational Research, 57*(3), 293-336.

Slavin, R. (1990). Achievement effects of ability grouping in secondary schools: A best-evidence synthesis. *Review of Educational Research, 60*(3), 471-499.

Spradley, J. P. (1979). *The ethnographic interview*. New York: Holt, Rinehart and Winston.

Sternberg, R. (1998). Abilities are forms of developing expertise. *Educational Researcher, 27*(3), 11-20.

Stobart, G. (2008). *Testing times: The uses and abuses of assessment*. London: Routledge.

Stone, C. (1998). Leveling the playing field: An urban school system examines equity in access to mathematics curriculum. *The Urban Review, 30*(4), 295-307.

Strauss, A. (1987). *Qualitative analysis for social scientists*. Cambridge: Cambridge University Press.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). London: SAGE.

Sturman, L., Ruddock, G., Burge, B., Styles, B., Lin, Y., & Vappula, H. (2008). England's achievement in TIMSS 2007, National report for England: Slough: NFER. Available at: http://www.nfer.ac.uk/research/projects/trends-in-international-mathematics-and-science-study-timss/

Sukhnandan, L., & Lee, B. (1998). *Streaming, setting and grouping by ability: A review of the literature*. Slough: National Foundation for Educational Research.

Thomas, J. A., Pedersen, J. E., & Finson, K. (2001). Validating the draw-a-science-teacher-test checklist (DASTT-C): Exploring mental models and teacher beliefs. *Journal of Science Teacher Education, 12*(3), 295-310.

Thrupp, M., Lauder, H., & Robinson, T. (2002). School composition and peer effects. *International Journal of Educational Research, 37*(5), 483-504.

Torbeyns, J., Verschaffel, L., & Ghesquiere, P. (2004). Strategic aspects of simple addition and subtraction: the influence of mathematical ability. *Learning and Instruction, 14*(2), 177-195.

Tucker-Drob, E., Rhemtulla, M., Harden, K., Turkheimer, E., & Fask, D. (2011). Emergence of a gene × socioeconomic status interaction on infant mental ability between 10 months and 2 years. *Psychological Science, 22*(1), 125-133.

Turkheimer, E., Haley, A., Waldron, M., D'Onofrio, B., & Gottesman, I. (2003). Socioeconomic status modifies heritability of IQ in young children. *Psychological Science, 14*(6), 623-628.

Useem, E. (1992a). Getting on the fast track in mathematics: School organizational influences on math track assignment. *American Journal of Education, 100*(2), 325-353.

Useem, E. (1992b). Middle schools and math groups: Parents' involvement in children's placement. *Sociology of Education, 65*(4), 263-279.

van Elk, R., van der Steeg, M., & Webbink, D. (2011). Does the timing of tracking affect higher education completion? *Economics of Education Review, 30*(5), 1009-1021.

Venkatakrishnan, H., & Wiliam, D. (2003). Tracking and mixed-ability grouping in secondary school mathematics classrooms: A case study. *British Educational Research Journal, 29*(2), 189-204.

Villa, R., Thousand, J., & Nevin, A. (2008). *A guide to co-teaching: Practical tips for facilitating student learning*. Thousand Oaks, CA: Corwin Press.

Warnock, M. (2005). *Special educational needs: A new look*. London: Philosophy of Education Society of Great Britain.

Webster, R., Blatchford, P., Bassett, P., Brown, P., Martin, C., & Russell, A. (2011). The wider pedagogical role of teaching assistants. *School Leadership and Management, 31*(1), 3-20.

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge: Cambridge University Press.

Wheeler, D. (2001). A mathematics educator looks at mathematical abilities. *For the Learning of Mathematics, 21*(2), 4-12.

White, J. (2005). Puritan intelligence: The ideological background to IQ. *Oxford Review of Education, 31*(3), 423-442.

White, J. (2006). *Intelligence, destiny and education: The ideological roots of intelligence testing*. Abingdon: Routledge.

White, P., Gamoran, A., Smithson, J., & Porter, A. (1996). Upgrading the high school math curriculum: Math course-taking patterns in seven high schools in California and New York. *Educational Evaluation and Policy Analysis, 18*(4), 285-307.

Wiliam, D. (2007). Keeping learning on track: Classroom assessment and the regulation of learning. In F. K. Lester Jr (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning: a project of the National Council of Teachers of Mathematics* (Vol. 2, pp. 1053-1098). Charlotte, NC: Information Age Publishing.

Wiliam, D., & Bartholomew, H. (2004). It's not which school but which set you're in that matters: The influence of ability grouping practices on student progress in mathematics. *British Educational Research Journal, 30*(2), 279-293.

Willingham, D., & Lloyd, J. (2007). How educational theories can use neuroscientific data. *Mind, Brain, and Education, 1*(3), 140-149.

Wilson, L. D. (2007). High-stakes testing in mathematics. In F. K. Lester Jr (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning: a project of the National Council of Teachers of Mathematics* (Vol. 2, pp. 1099-1110). Charlotte, NC: Information Age Publishing.

Winn, W., & Wilson, A. (1983). The affect and effect of ability grouping. *Contemporary Education, 54*(2), 119-125.

Wright, A. (2004). *Religion, education and post-modernity*. London: RoutledgeFalmer.

Wright, A. (2007). *Critical realism*. Paper presented at the MPhil/PhD Research Training Workshops: Theory and Practice in Social Science Research, King's College London.

Yackel, E., & Rasmussen, C. (2002). Beliefs and norms in the mathematics classroom. In G. Leder, E. Pehkonen & G. Törner (Eds.), *Beliefs: A Hidden Variable in Mathematics Education?* (pp. 313-330). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Yates, S. (2000). Task involvement and ego orientation in mathematics achievement: A three year follow-up. *Issues in Educational Research, 10*(1), 77-91.

Youell, B. (2006). *The learning relationship: Psychoanalytic thinking in education*. London: Karnac.

Zan, R., Brown, L., Evans, J., & Hannula, M. (2006). Affect in mathematics education: An introduction. *Educational Studies in Mathematics, 63*(2), 113-121.

Zeidner, M., & Schleyer, E. J. (1998). The big-fish-little-pond effect for academic self-concept, test anxiety, and school grades in gifted children. *Contemporary Educational Psychology, 24*(4), 305-329.

Zevenbergen, R. (1996). Constructivism as a liberal bourgeois discourse. *Educational Studies in Mathematics, 31*(1/2), 95-113.

Zevenbergen, R. (2005). The construction of a mathematical habitus: Implications of ability grouping in the middle years. *Journal of Curriculum Studies, 37*(5), 607-619.

Appendices

Appendix A: Systematic Literature Review Methodology

Background

This systematic review method was written in 2007 at the beginning of the study. It was used to produce the initial literature review. The sourcing, organisational and inclusion criteria were applied subsequently throughout the study in order to keep the review up to date. The numbers included within this writing refer to the original literature search and do not include the sources identified during subsequent searches.

Aim of the Literature Review

The aim of my literature review was to establish the need for the study, ensuring its originality, justifying my research questions, theoretical perspective and approach. There already existed a vast literature in the field of ability in (mathematics) education, brought together within copious reviews. The need did not exist for another similar review. My study, therefore, does not contain a literature review in the traditional sense, but applied this systematic review in order to clearly establish the need for further work and an original perspective.

Previous reviews within ability and education employed a confusing array of literature review methods, some explicit (e.g. Kulik & Kulik, 1982a; Slavin, 1987, 1990), but many not. A lack of explicitness may make it difficult to establish the credibility of the review and adds to arguments around the polemic nature of the literature. It was my intention to employ an explicit, systematic method, making the processes I employed clear to the reader and producing a reliable and replicable review.

The broad aim for my review was addressed through the following research questions and objectives:

Research Questions

1. Is the literature contained within the ability grouping literature reviews sufficient for my study?

2. How does the literature define ability and associated terminology? Do these definitions have an impact on study methodology and results?

3. Does the literature conceptualise ability in a way that will allow me to apply critical realist notions of emergent structures and causal properties?

4. To what extent does the literature consider ability discourses as a part of, or separate from, ability grouping?

5. What methodologies have previously been employed and to what degree of success?

6. To what extent does the literature consider multiple effects (attitudinal and attainment) of ability grouping?

7. Do different educational levels lead to different conceptualisations, methodologies and study results?

8. Is mathematics conceptualised as a special case within the literature?

9. What is particular about the UK and ability grouping?

10. To what extent is the literature polemic? What attempts have been made to address this?

Research Objectives

- Establish whether the objectives below can be met solely through the ability grouping literature reviews or if a broader perspective is required

- Identify specific themes within the required literature not covered by the reviews (if a broader perspective is required – see above)

- Establish the definitions of ability (and other terminology) used within the literature

- Evaluate the implications of the definitions used (if at all) on the overall research

- Classify studies by a focus on ability grouping or other ability discourses and practices

- Identify from above classification how studies exploring ability discourses have been operationalised

- Identify different methodologies employed in ability studies

- Identify the dependent and independent variables used in various studies

- Evaluate the impact of different methodologies on types of outcome and study results

- Structure the review through different educational levels (primary, secondary etc.) and apply previous objectives to this stratification
- Identify how the educational subject(s) considered impact on the study methodology and outcomes
- Distinguish what is particular about the cultural specificity of the UK context in relation to ability grouping
- Locate the literature within key themes and arguments and identify repetitions within these arguments

Sourcing the Literature

The vast literature around ability makes traditional literature searching methods less feasible. For example, an educational literature database search using the keyword 'ability' in the title or abstract produces over 75000 documents. Limited to ability and education, ability and mathematics or ability-grouping still produces numbers of documents in excess of 15000, 4000 and 1500 respectively. A far more specific search such as ability & mathematics & education, which may unwittingly eliminate vital literature, still produces over 1300 documents, a number of which appear unrelated to my study. Such difficulty with a vast literature highlights the need to apply a clear, systematic and defensible method to my literature sourcing as well as to how I actually carried out the literature review.

Various reviews and review methods were explored. Although a set of different systematic approaches were identified, these were not considered appropriate to the aim of my review as they generally sought to produce a full review rather than address specific questions of the sort I am asking. Difficulties in applying established review methods have been noted previously by Coffield et al. (2004) in their review of the learning styles research. Their solution, to apply particular processes from the systematic review method but to supplement this with their own processes and criteria, is well defended and appears applicable to my aim. I therefore began from a position broadly similar to that of Coffield et al., encompassing some aspects of the systematic literature review (Badger, Nursten, Williams, & Woodward, 2000; EPPI-Centre, 2006), but adapted through the inclusion of my own systematic processes.

Literature was sourced through four distinct stages, the first three of which are represented in Figure 17. As my PhD builds on two earlier studies, I was previously aware of much of the literature. From this awareness, I located the main reviews of the ability-grouping literature. These reviews are widely discussed and referenced making it fairly simplistic to ensure that all reviews were included. This stage produced a total of 15 reviews.

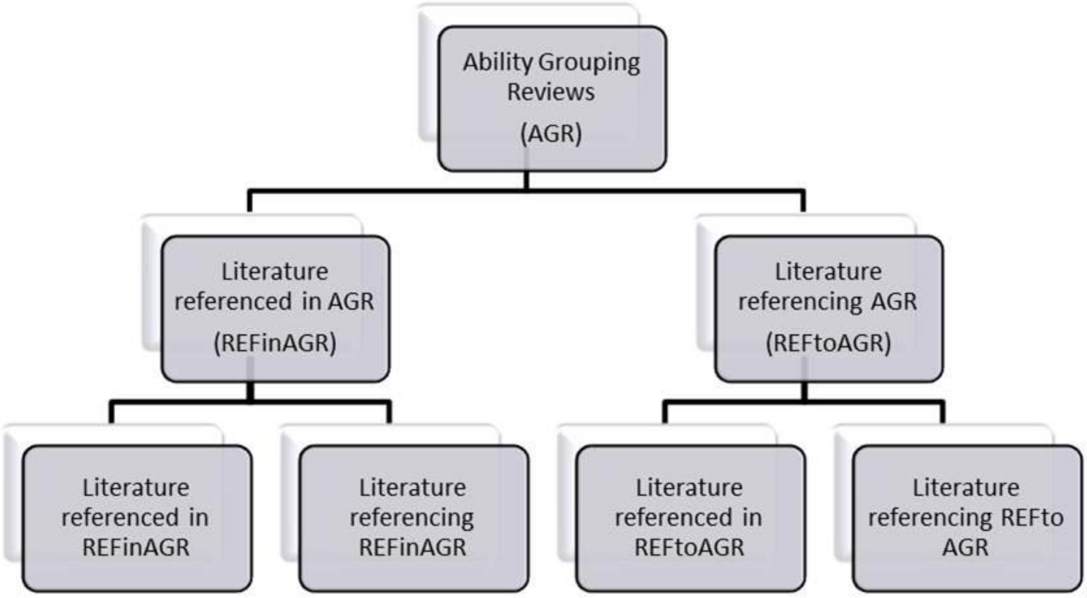


Figure 17: Sourcing of literature for review

The second stage of literature sourcing had two sub-components. Using electronic forward and backward citation searches, the literature referred directly to in, and the literature referring directly to, the 15 reviews was located. The third stage involved a repetition of the second stage with the literature sourced in the second stage. Although this process could have been repeated ad infinitum, it was found that at the third and subsequent repetitions, no new relevant literature was forthcoming. ‘Relevant’ was established through the application of my informed judgement, a strategy defensible through my longitudinal involvement with this field. In addition to these linked stages, an overarching educational database search was performed using the keywords used by Sukhnandan & Lee (1998) in their review of the literature. It was deemed acceptable to apply this list as it had been used in a recent full review and would provide more than was necessary for my review. In addition, to encompass the specific focus of my study, further keywords of math/maths/mathematics and primary/elementary were combined with Suknandan & Lee’s list. However, because this method produced an abundance of literature, the results were judged for their suitability through the application of informed judgement as to relevance in relation to the criteria of the main strategy. As the main sourcing strategy shown in Figure 17 was intended to be over-inclusive, a very limited collection of literature that had not been sourced earlier was revealed, representing only 10% of the total literature considered. This suggests my strategy to be defensible.

Approaches to the Literature Review

The literature sourcing strategy was intended to be over-inclusive and not reliant on my judgement in order to ensure it was reliable and could be replicated. This strategy produced over 200 documents which needed to be approached systematically to ensure rigour. In similarity with the approach of Coffield et al., Endnote software was used to file the literature and add keywords and codes for easy retrieval. Codes as appear in Figure 17 were added to enable clarity in sourcing.

The literature was then assessed in order to answer the questions set out previously. This was accomplished in three stages. Initially the reviews were read broadly to establish that further literature would be required to fully answer all my questions. The second stage was the most complicated and involved the actual review as described below. The final third stage was to bring together the evidence amassed during the second stage in order to assess how the answers to my questions work together to fulfil the aim of this review and move my study forwards.

During the second stage, the questions were worked through in an order appropriate to the study with evidence sought within the literature. The full literature previously sourced was not applied to each question, but worked through in a consistent, systematic way until either no new answers were prevailing or informed judgement was used to establish that enough evidence was available. This systematic ordering of the literature for inspection involved two filtering systems resulting in a thorough Endnote coding list. The first system, shown in Figure 18, is an adaptation of the 'onion model' used by Coffield et al. (2004, p. 17) in their selection of literature for review. The sourced literature was divided into four 'layers' of importance, and worked through in this order, from ability grouping reviews outwards, for each question. It was considered important to explore mathematics as a special case, both because this is often the way the subject is conceptualised in the literature and because this relates to the context of my study. The codes given in brackets with each 'layer' represent the initial coding applied to the total literature.

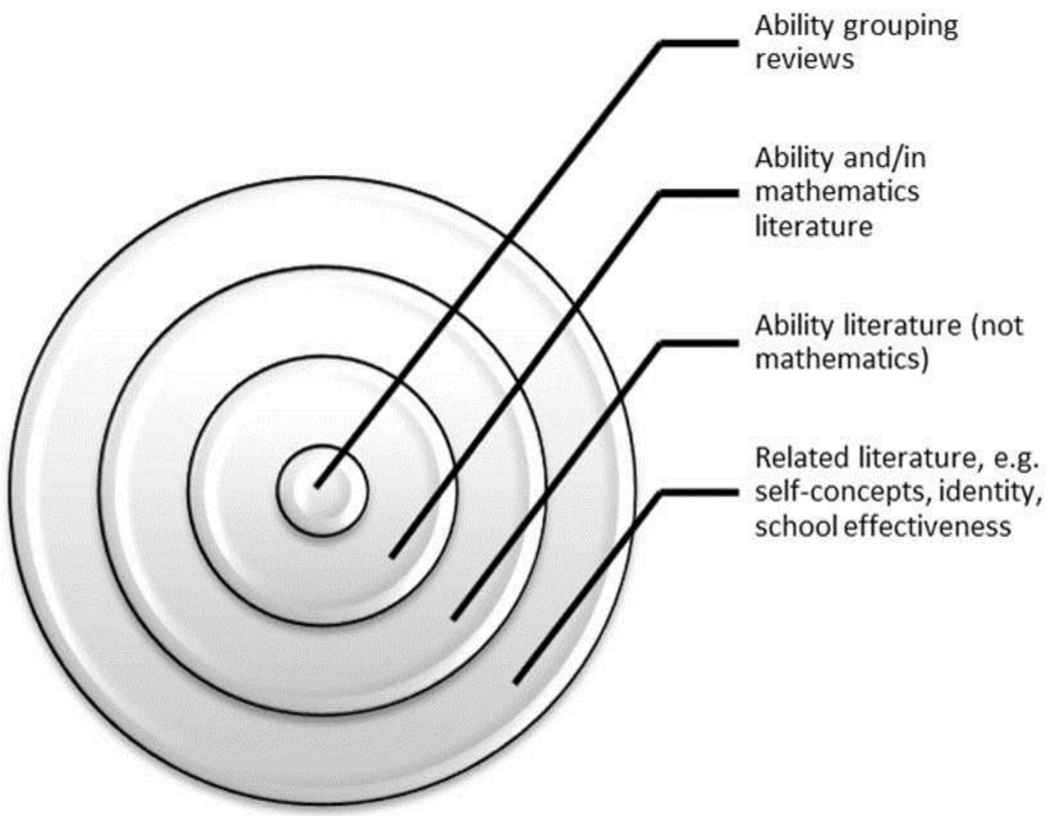


Figure 18: Hierarchical organisation for literature review

Despite this ordering, it was found that some layers contained too much literature with some clearly more important to my study than others (such as ability literature - not maths). A second literature hierarchy was therefore developed, to be applied to each layer of Figure 18, giving a sub-level of systematic ordering. This development is represented diagrammatically in the flowchart in Figure 19. This sub-ordering required each level of Figure 18 to be assessed independently. The literature within each level was assessed and ordered by whether it related to primary education, whether it related to the UK context and finally on the basis of an age/relevance judgement. This judgement matches that made by Harlen and Malcolm (1999, p. 4) in their review of ability grouping, whereby literature was judged as to whether 'there is relevance to current debates either because of being conducted recently or having enduring significance'. This judgement was made on a binary 1/0 basis.

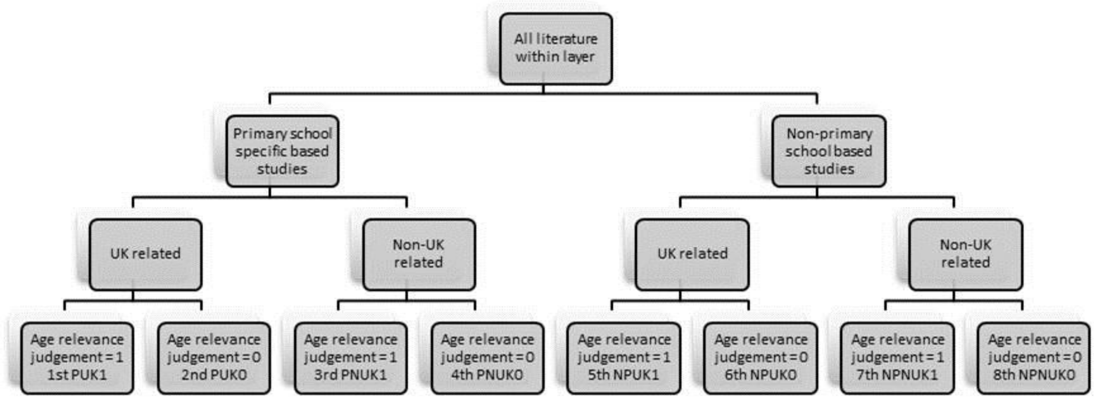


Figure 19: Literature sub-ordering within hierarchy rings

These two inter-linking hierarchies (Figure 18 and Figure 19) combine to give a 32 stage levelling to the total literature sourced (Table 12). Once produced, this extensive labelling was applied to all the literature sourced through the method described in Figure 17, and the relevant codes were applied to the Endnote entries. This prioritised the literature, giving a reliable way in which it could be used to address each question, either in a linear fashion, or through highlighting relevant and specific literature groups for each question/objective.

It was found on entering the literature into this levelling system that clumps appeared in places that could be problematic to the review. One such place was within the ability and mathematics literature where it was felt that the group was too over-inclusive to address the earlier research questions. As such, after the initial sorting, the stages within this group were each subdivided into those concerning ability grouping in mathematics and those taking a broader view of mathematical abilities.

Following the sorting of the literature, the number of documents within each group ranged from 0 to 20 (mean = 6.84). These represent manageable groups of literature to work with, although it is interesting to note where extremes occur as they become indicative of my literature questions and the subsequent location of my study.

Priority	Endnote Code	Number of documents
1	Abrevpuk1	0
2	Abrevpuk0	0
3	Abrevpnuk1	0
4	Abrevpnuk0	2
5	Abrevnpuk1	7
6	Abrevnpuk0	1
7	Abrevnpnuk1	0
8	Abrevnpnuk0	6
9	Abmathpuk1	8
10	Abmathpuk0	1
11	Abmathpnuk1	4
12	Abmathpnuk0	11
13	Abmathnpuk1	15
14	Abmathnpuk0	1
15	Abmathnpnuk1	13
16	Abmathnpnuk0	4

Priority	Endnote Code	Number of documents
17	Abmiscpuk1	8
18	Abmiscpuk0	4
19	Abmiscpnuk1	5
20	Abmiscpnuk0	12
21	Abmiscnpuk1	20
22	Abmiscnpuk0	9
23	Abmiscnpnuk1	14
24	Abmiscnpnuk0	17
25	Abrelpuk1	11
26	Abrelpuk0	0
27	Abrelpnuk1	6
28	Abrelpnuk0	5
29	Abrelnpuk1	9
30	Abrelnpuk0	4
31	Abrelnpnuk1	9
32	Abrelnpnuk0	15

Table 12: Systematic literature levelling system

Appendix B: Ethical Approval

KING'S College LONDON

University of London

Rachel Marks
Department of Education and Professional Studies
Waterloo Bridge Wing
Franklin-Wilkins Building
Waterloo Road
London, SE1 9NH

13th March 2007

Dear Rachel,

Re: REPSSPP(W)-05/06-87 Discourses of ability and primary school mathematics: Production, reporoduction and contestation

Approved in full

Thank you for your revised application clarifying our queries. Your study is **now approved** on the understanding that you will follow the protocol as approved. It is the responsibility of the Researcher to notify the REP immediately if you become aware of anything which casts doubt upon the conduct, safety or an unintended outcome of the study for which approval was given.

The Panel suggests that the opt-out consent form for parents be altered. At the moment, it is confusing because there is a phrase in the letter that says to return the form only if you do not want your child to take part. Then on the cut-away part (for returning) there is space to delete as appropriate whether they do or do not want their child to participate. Information in these two locations should be consistent.

If there are any amendments, which in the opinion of you or your supervisor could radically alter the nature of the approved study, a revised application should be submitted. Proposed minor changes should be presented in a letter.

Please read the enclosed the Notes for Researchers of Approved Projects.

We wish you every success with this work.

With best wishes

Annalisa Fagan

Department Secretary & PA to Professor Jonathan Osborne, Head of Department of Education & Professional Studies, School of Social Science & Public Policy

INFORMATION SHEET FOR PARTICIPANTS
[Protocol Number: REPSSPP(W)-05/06-87]

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

KING'S College LONDON
University of London

Grouping and Learning in Primary School Mathematics

I would like to invite you to participate in this PhD research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

You are being requested to participate in this study. Participation is entirely voluntary.

The aim of this study is to explore how pupils' mathematical ability is constructed in primary schools. It is expected that this study will contribute to existing knowledge on best practice in grouping pupils for the teaching of mathematics/numeracy in primary classrooms.

The main study will last for one academic year from October 2007 – July 2008. If you volunteer to take part:

(i) You will be asked to participate in a recorded interview towards the beginning of the second term lasting for approximately one hour.

(ii) Your class/set will be observed approximately twice a term during their usual mathematics lessons, with the focus being on pupil-pupil and pupil-teacher interactions. Some of these observations will be audio-recorded.

(iii) A numeracy test will be conducted with your class/set at the beginning and end of the school year, which I will mark.

(iv) An attitudinal questionnaire will be conducted with your class/set at the beginning and the end of the year.

(v) You will be asked to select three focus pupils from your class/set who I will focus on in my observations and who I will interview as a group and on an individual basis.

No risks or discomfort are anticipated to be caused to you through your participation in this study. No feedback on any individual teacher who takes part in the study will be given to the school.

As a volunteer in this study, it is hoped that through your participation you will gain a deeper understanding of and further insight onto the mathematics learning of your class/set.

I will make all the data I collect anonymous during this study. I will give all research participants a pseudonym. It will not be possible to identify any research participant or school in any report written. All information will be stored securely at King's College, London in compliance with the Data Protection Act and will be securely destroyed after a period of seven years.

Researcher Contact Information

Should you wish to obtain any further details of this project please do not hesitate to contact me:

Rachel Gwendoline Marks
Email: rachel.marks@kcl.ac.uk

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

KING'S College LONDON
University of London

Grouping and Learning in Primary School Mathematics

King's College Research Ethics Committee Ref: REPSSPP(W)-05/06-87

Thank you for considering to take part in this research. The person organizing the research must explain the project to you before you agree to take part.

If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

i. *I understand that if I decide at any other time during the research that I no longer wish to participate in this project, I can notify the researcher involved and be withdrawn from it immediately.*

ii. *I consent to the processing of my personal information for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.*

Participant's Statement:

I ____ agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet about the project, and understand what the research study involves.

Signed:______________________________ Date: _________________________

Researcher's Statement:

I, Rachel Gwendoline Marks, confirm that I have carefully explained the nature, demands and any foreseeable risks (where applicable) of the proposed research to the volunteer.

Signed: RMarks Date: October 2007

INFORMATION SHEET FOR PARTICIPANTS
(Main Study Focal-Pupils)
[Protocol Number: REPSSPP(W)-05/06-87]

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

KING'S College LONDON
University of London

Grouping and Learning in Maths Lessons

I would like to invite you to be a focal pupil within my project. This sheet, which I will discuss with you, gives you more information than the sheet I gave everyone in your class.

You do not have to be a focal pupil. It will not matter if you don't take part. If you do not understand anything you can ask me or someone else.

My project is about how children like you learn maths and how they feel in maths lessons. It should help your teachers make your maths lessons better. I want to focus on different children within your class to help me understand how you feel about maths lessons.

You will do the same tests and written questions in my study at the same time as everyone else in your class. I will not be giving you or your teachers your test scores, or telling them what you write.

When I come to your maths lessons, I will sometimes want to watch what you do and say carefully so that I can try to understand what your maths lessons are like for you. To help me remember what happens, I would like to record what you and your teacher say during some of your lessons. This might mean that you will wear a microphone for some of your maths lessons.

I will ask to talk to you about your maths lessons at different times during the year. Sometimes I will talk to you on your own and sometimes I will talk to you with one or two other children from your maths class. When I talk to you, I will record our conversation so that I can listen to it again and write about it.

When I write about your maths lessons and about what you say when you talk to me, I will give you a different name so that no-one except me will know what you have said. I will make sure that no-one else can look at anything with your name on it. When I have finished my study, I will destroy all the recordings I make of you so that no-one else can listen to them.

If you want to find out any more information, you can email me: rachel.marks@kcl.ac.uk

If you want to be a focal pupil in my study, you can keep this sheet. I will ask you to sign another sheet saying that you want to take part. You can stop being in my study at any time.

CONSENT FORM FOR PARTICIPANTS (PUPILS) IN RESEARCH STUDIES

Please fill in this form after you have been told about the project.

King's College LONDON

University of London

Grouping and Learning in Maths Lessons

King's College Research Ethics Committee Ref: REPSSPP(W)-05/06-87

Thank you for deciding to take part in this project. The person organizing it must tell you what will happen before you take part. If you have any questions please ask her.

You will be given a copy of this sheet to keep.

1. I do not have to take part if I do not want to. I can stop taking part whenever I want to.
2. I am happy for information about me to be written down as long as no-one else can read it and it is kept safe.

Pupil's Statement:

I (write your name here)____________________ , have been told about this project. I know what will happen. I want to take part. I have read the notes on this sheet and on the information sheet.

Signed Date

Researcher's Statement:

I, Rachel Marks, have carefully explained my project to the pupil named above.

Signed Date

Appendix C: Research Question and Method Mapping

Main Question: In what ways are discourses of ability produced, reproduced and transformed in the primary mathematics classroom?

Research Sub-Questions:

A. What is the role of teachers in producing, reproducing and transforming pupils' mathematical ability?
B. What is the role of pupils in producing, reproducing and transforming their own and others' mathematical ability?
C. What effects do discourses of ability have on pupils' engagement with and achievement in primary mathematics?

Data Type	Purpose	Aim
Attainment Tests	• To measure gains in pupils' attainment • To explore differences in gains between pupils exposed to different discourses	C
Attitudinal Questionnaires	• To measure changes in pupils' attitudes (conceptualised as factors pertaining to engagement with learning mathematics) using a stable measure over the year • To explore how pupils' initial, final and attitudinal changes relate to the use of discourses of ability	C
Classroom Observations	• To gain a general understanding of how discourses of ability may be used/stratified within classes and sets • To explore the use / production / transformation of discourses of ability within pupil/pupil and teacher/pupil interactions • To explore differences in these patterns across sets / ability labels	A, B A, B
Pupil Group Interviews	• To explore how pupils use discourses of ability and what their frameworks of reference are • To explore how pupils challenge others' ideas of mathematical ability • To explore pupils' engagement with mathematics and the impact of discourses of ability now and as perceived in the future	B, C
Pupil Individual Interviews	• To explore how pupils use discourses of ability and what their frameworks of reference are • To explore how pupils challenge teachers' and others' ideas of mathematical ability • To explore pupils' engagement with mathematics and the impact of discourses of ability now and as perceived in the future	A, B, C
Teacher Individual Interviews	• To explore the frameworks teachers draw on in forming ideas of mathematical ability • To investigate reasons underlying aspects of teachers' frameworks • To explore the significance of discourses of ability in teachers' talk	A

Appendix D: Attainment Test Booklet

Numeracy assessment test 4

Pupil's booklet

Year 4

Name	
School	
Class	
Date	

1. Which number?

a)

b)

c)

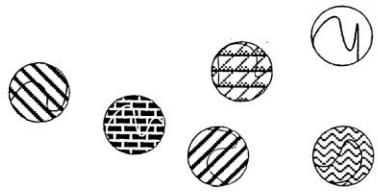
d)

e)

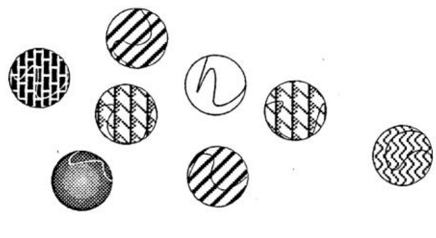
f)

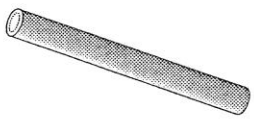
2. Marbles, rock and eggs

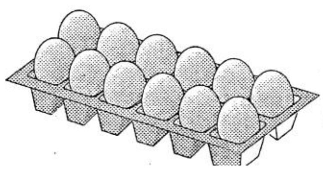
a) Jane wins



b) Peter wins

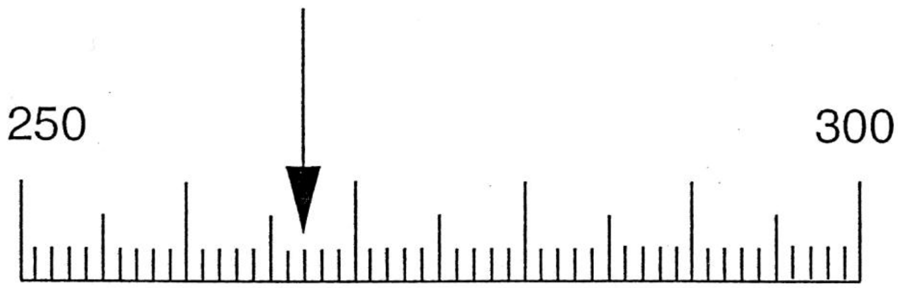


c) 

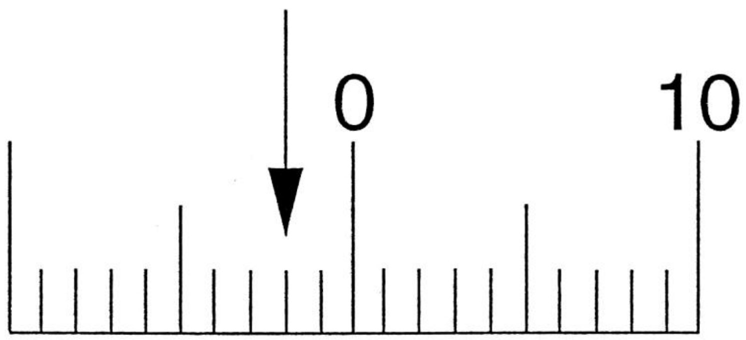
d) 

3. Find the number

a)



b)



4. One more

a) ☐ ____________

b) ☐ ____________

5. One less

a) [ ] ____________

b) [ ] ____________

c) [ ] ____________

6. School fair

a) Natasha bought____cakes.

b) Rajesh bought____cakes.

c) Dawn bought ____ apples.

d) Gary bought ____ apples.

e) Lynn bought ____ boxes of cakes.

f) Beth bought ____ bags of apples and ____ loose apples.

7. What's the answer?

30 + 20 = 50
30 + 21

86 + 57 = 143

a)

b)

c)

d)

e)

f)

8. Which keys do you press?

a)

b)

c)

d)

e)

f)

g)

9. Times

a)

b)

c)

d)

10. Ten

a)

b)

c)

11. One hundred

a)

b)

c)

d)

12. Number stories

a) $\boxed{}$

b) $\boxed{}$

c) $\boxed{}$

d)

Monday	Tuesday	Wednesday

13. Ten again

a) $\boxed{}$

b) $\boxed{}$

14. Which sum?

a)

3 x 6	6 – 3
6 + 3	3 – 6
18 ÷ 3	6 ÷ 3
6 x 3	3 + 3

---

b)

87 x 3	261 + 87
87 ÷ 261	261 – 87
261 x 87	261 ÷ 87
87 – 261	87 + 174

15. Larger, smaller

a) $\frac{1}{4}$ $\frac{3}{4}$ b) $\frac{3}{7}$ $\frac{5}{7}$ c) $\frac{3}{5}$ $\frac{3}{4}$

16. Which order?

a) 0.07 0.23 0.1

b) 0.7 0.6

17. Nearest in size

a) 100 82 180 150 200 190

b) 3 30 2 20 0 1

c) 0.1 10 0.2 20 0

18. Carrot Soup

Carrot soup recipe for three people.

6 carrots

2 onions

1 litre of water

2 stock cubes

a) ________________ carrots

b) ________________ onions

c) ________________ carrots

d) ________________ water

e) ________________ carrots

Appendix E: Example of School Attainment Test Feedback

2007-2008

Numeracy Attainment Test Results

Grouping and Learning in Mathematics Lessons

Summary of the results from the Numeracy Attainment Test across all mathematics sets for Year 4 and Year 6 at [redacted] Primary School during the academic year September 2007 – July 2008.

Rachel Gwendoline Marks

Report Date: February 2009

Numeracy Attainment Test Results

This report provides feedback on the Numeracy attainment tests conducted at [redacted] Primary School in October 2007 and July 2008. These tests were conducted as part of the PhD research project entitled 'Grouping and Learning in Mathematics Lessons'. Pupils in year 4 and year 6 completed the tests on both occasions. For each year group this report gives the range of Numeracy attainment and gains achieved at the end of the academic year, both for the whole year group and broken down across the sets. No individual pupil is referred to nor is it possible to ascertain individual identities from the information provided here.

The tests used were developed at King's College, London, over a period of 30 years by Professor Margaret Brown, Professor Mike Askew and colleagues. They were initially designed as one-to-one diagnostic interview tests and later developed for use with whole classes with additional questions reflecting the Primary Framework.[1] As whole class tests they were used extensively within the Leverhulme Numeracy Research Programme from which statistics on pupils' numeracy progress have been developed.[2]

The test questions were designed to emphasis mental processes and address contextual as well as purely numerical items. It was intended that most children would attempt every question, with some questions being answered correctly by most children and some being answered incorrectly by most. The majority of the questions sought short open responses with a few providing multiple choice answers.

Broadly, the test questions could be broken down into the four number based objectives categories within the Primary Framework for mathematics:

- Using and applying mathematics
- Counting and understanding number
- Knowing and using number facts
- Calculating (within the tests, especially at year 6, a large number of the 'calculating' questions focussed on fractions, decimals, percentages and ratio)

The Framework makes no distinction between, for instance, counting and understanding number with integers or fractions, or using and applying mathematics within 'real-world' or number based contexts although these were broken down for this analysis and some distinction is made when discussing relative areas of strength and difficulty for each set.

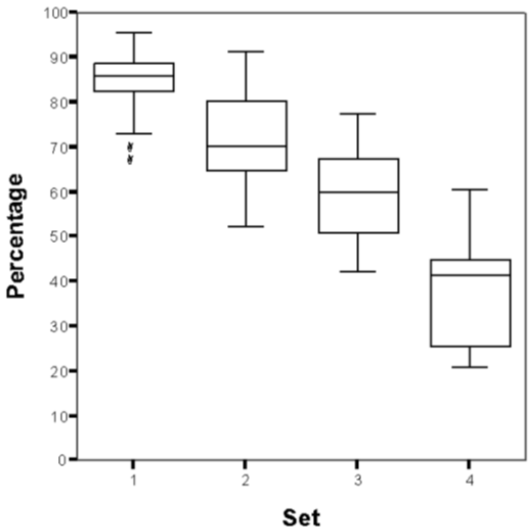
[1] The individual diagnostic tests are published by BEAM: Denvir, H. & Bibby, T. (2004). *Diagnostic Interviews in Number Sense*. London: BEAM Education.

[2] For the development of these statistics and details of cohort progression, see: Brown, M., Wiliam, D., Millett, A., & Hodgen, J. (Forthcoming). Progression in children's learning. In M. Askew, M. Brown & A. Millett (Eds.), *Learning about number: Interactions and outcomes in primary classrooms*. Dordrecht: Springer.

Year 4 Test Results

The results reported here are for all pupils in sets 1 – 3 (inclusive) who took both the October 2007 and July 2008 administrations of the test. Not every pupil was present on both testing days and any pupil unable to access the test was excluded, hence these results relate to a slightly different population than the entirety of year 4. Set 4 is included in the numeracy score/range results although these figures may be misleading (lower than envisaged) as pupils only completed two-thirds of the test. Where pupils moved sets at any time between October 2007 and July 2008, their results are included within their **initial** set position.

Numeracy Scores



- The graph shows the spread of scores and the median score for each set in July 2008.
- A Rasch analysis allows the attainment range and gains to be quantified in terms of maths ages.
- The average (mean) numeracy age at July 2008 for all pupils in year four was roughly equivalent to 9 years and 7 months.
- There was an approximate range of 5 years and 7 months between the lowest and highest numeracy ages.

Numeracy Gains

- The average gain between October 2007 and July 2008 for all pupils in year four (sets 1 – 3) was equivalent to 10 months which is slightly higher than the national mean age gain of 9 months.

Areas of Strength and for Development

This table shows the four question areas listed in order of relative difficulty for each set.

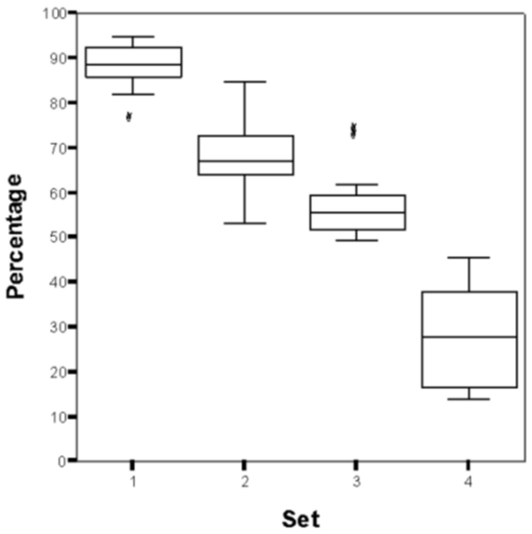
Set	Question categories found relatively easy by pupils in set	→		Question categories found relatively more difficult by pupils in set
1	Knowing and using number facts	Counting and understanding number	Calculating	Using and applying mathematics
2	Counting and understanding number	Knowing and using number facts	Calculating	Using and applying mathematics
3	Counting and understanding number	Knowing and using number facts	Calculating	Using and applying mathematics
4	Knowing and using number facts	Counting and understanding number	Calculating	Using and applying mathematics

- There was very little difference between the question areas that each set found relatively easier or more difficult.
- When broken down, sets 2 – 4 found the fractions and decimals elements more difficult, particularly in terms of calculating.
- Whilst all pupils found using and applying mathematics hardest, set 1 pupils found this more difficult with 'real-world' contexts whilst set 4 pupils found it more difficult with number based contexts.

Year 6 Test Results

The results reported here are for all pupils in sets 1 – 4 (inclusive) who took both the October 2007 and July 2008 administrations of the test. Not every pupil was present on both testing days, hence these results relate to a slightly different population than the entirety of year 6. Where pupils moved sets at any time between October 2007 and July 2008, their results are included within their **initial** set position. This is particular pertinent to those pupils who moved in January 2008 from Set 4 to Set 3 and may elevate the maths ages and gains of set 4.

Numeracy Scores



- The graph shows the spread of scores and the median score for each set in July 2008.
- A Rasch analysis allows the attainment range and gains to be quantified in terms of maths ages.
- The average (mean) numeracy age at July 2008 for all pupils in year six was roughly equivalent to 11 years and 11 months.
- There was an approximate range of 6 years and 3 months between the lowest and highest numeracy ages.

Numeracy Gains

- The average gain between October 2007 and July 2008 for all pupils in year six was equivalent to 1 year which is slightly higher than the national mean age gain.

Areas of Strength and for Development

This table shows the four question areas listed in order of relative difficulty for each set.

Set	Question categories found relatively easy by pupils in set →			Question categories found relatively more difficult by pupils in set
1	Counting and understanding number	Knowing and using number facts	Calculating	Using and applying mathematics
2	Knowing and using number facts	Counting and understanding number	Using and applying mathematics	Calculating
3	Knowing and using number facts	Counting and understanding number	Using and applying mathematics	Calculating
4	Knowing and using number facts	Counting and understanding number	Using and applying mathematics	Calculating

- With the exception of set 1, there was no difference between the question areas that each set found relatively easier or more difficult.
- Set 1 appeared to have a relatively stronger foundation in understanding number which may have supported them across the mathematics curriculum
- With sets 2 – 4, the fractions, decimals, percentages and ratio elements contributed to their relative difficulty with the calculating questions.
- Set 1 found the using and applying mathematics questions set within a 'real-world' context relatively difficult in comparison to the solely number based questions within the test.

Appendix F: Pupil Questionnaire

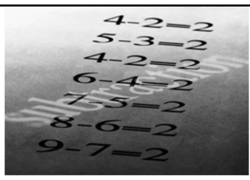
Beliefs about causes of success in mathematics (Children do well in maths if…)

Factor	Loading	Original Presentation	Change	My Wording	Question Number
Interest and Effort	0.79	They work really hard			5
	0.80	They always do their best			1
	0.68	They are interested in learning			9
Understanding	0.72	They like to think about math	Language	They like to think about maths	3
	0.73	They try to understand instead of just getting answers to problems	Clarification	They try to understand instead of just getting the right answers to the problems	7
	0.64	The try to figure things out	Language	They try to work maths problems out	11
Competitiveness	0.69	They try to get more answers right than the others			2
	0.70	They try to do more work than their friends			10
	0.75	They are smarter than the others	Language	They are cleverer than the other children	6
Extrinsic	0.72	The behave nicely			4
	0.77	Their papers are neat	Language	Their work is neat	8
	0.73	They are quiet in class			12

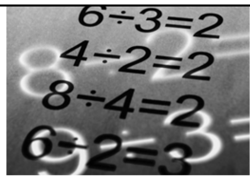
Motivational Orientation Items (I feel really pleased in maths when…)

Factor	Loading	Original Presentation	Change	My Wording	Question Number
Task Orientation I	0.69	I solve a problem by working hard			1
	0.55	The problems make me think hard			5
	0.73	What the teacher says makes me think	Clarification	Something the teacher says makes me think	9
	0.49	I keep busy			13
	0.65	I work hard all the time			16
Task Orientation II	0.59	Something I learn makes me want to find out more			3
	0.81	I find a new way to solve a problem			7
	0.43	Something I figure out really makes sense	Language	A problem I work out really makes sense	11
	0.59	Something I figure out makes me want to keep doing more	Language	A problem I work out makes me want to keep	15
Ego Orientation I	0.82	I know more than the others	Clarification	I know more than the other children	2
	0.79	I am the only one who can answer a question			10
Ego Orientation II	0.63	I finish before my friends			6
	0.79	I get more answers right than my friends			14
Work Avoidance	0.61	I don't have to work hard			4
	0.83	All the work is easy			8
	0.80	The teacher doesn't ask hard questions			12

These are the pages from the pupil questionnaire. They were printed back-to-back on A3 and folded to form an A4 booklet. The same questionnaire was used for the pre- and post-tests.



Grouping and Learning in Maths Lessons



I am interested in your opinions about learning maths. People have lots of different opinions and this is OK. Often adults talk about what children should do in school but they often don't know what children think about school and about learning maths. I want to find out your different opinions about things in maths lessons that make you feel good and things that don't.

I will be the only person who reads your opinions. I will not give your questionnaire to anyone else, including your teachers, to look at. I will ask you to do this questionnaire now and again at the end of the school year, because I am interested in seeing how your opinions change.

Name				
Class				
School				
Date				
Boy			Girl	
Administration	1	2	Code No.	

KING'S *College* LONDON
University of London

This questionnaire is part of a PhD study called 'Grouping and Learning in Maths Lessons'. It is being carried out within the Department of Education & Professional Studies at King's College, London, and is funded by a studentship from the Economic and Social Research Council (award number PTA-031-2006-00387). If you would like more information on the project then please contact Rachel Marks by email at rachel.marks@kcl.ac.uk.

Children do well in maths if …

1. They always do their best

   YES Yes ? No **NO**

2. They try to get more answers right than the others

   YES Yes ? No **NO**

3. They like to think about maths

   YES Yes ? No **NO**

4. They behave nicely

   YES Yes ? No **NO**

5. They work really hard

   YES Yes ? No **NO**

6. They are cleverer than the other children

   YES Yes ? No **NO**

7. They try to understand instead of just getting the right answers to the problems

   YES Yes ? No **NO**

8. Their work is neat

   YES Yes ? No **NO**

9. They are interested in learning

   YES Yes ? No **NO**

10. They try to do more work than their friends

    YES Yes ? No **NO**

11. They try to work maths problems out

    YES Yes ? No **NO**

12. They are quiet in class

    YES Yes ? No **NO**

I feel really pleased in maths when …

1. I solve a problem by working hard

YES	Yes	?	No	**NO**

2. I know more than the other children

YES	Yes	?	No	**NO**

3. Something I learn makes me want to find out more

YES	Yes	?	No	**NO**

4. I don't have to work hard

YES	Yes	?	No	**NO**

5. The problems make me think hard

YES	Yes	?	No	**NO**

6. I finish before my friends

YES	Yes	?	No	**NO**

7. I find a new way to solve a problem

YES	Yes	?	No	**NO**

8. All the work is easy

YES	Yes	?	No	**NO**

9. Something the teacher says makes me think

YES	Yes	?	No	**NO**

10. I am the only one who can answer a question

YES	Yes	?	No	**NO**

11. A problem I work out really makes sense

YES	Yes	?	No	**NO**

12. The teacher doesn't ask hard questions

YES	Yes	?	No	**NO**

I feel really pleased in maths when …

13. I keep busy

YES	Yes	?	No	**NO**

14. I get more answers right than my friends

YES	Yes	?	No	**NO**

15. A problem I work out makes me want to keep doing more problems

YES	Yes	?	No	**NO**

16. I work hard all the time

YES	Yes	?	No	**NO**

How good are you at maths?

Best in maths ⟷ Worst in maths

How much do you like maths?

Really like maths ⟷ Really don't like maths

Thank you for completing this questionnaire

Appendix G: Piloting Observation Methods

I had originally intended to use observational methods / instruments allowing the same data to be analysed both quantitatively and qualitatively. In this appendix, I discuss the development and piloting of such instruments.

Using the research questions as a basis, I started with four research objectives applicable to the use of observational methods:

- To explore the use of different discourses of ability by focal-pupils
- To explore the use of different discourses of ability by class-teachers
- To explore aspects of engagement with mathematics for different focal-pupils
- To explore teacher behaviours with/towards different focal-pupils

It was expected that some aspects of the observational data collection would have a more qualitative focus whereas others would be predominantly quantitative. A diagram (see Figure 20) was produced showing the balance and interrelation between quantitative and qualitative observation in relation to the four objectives. In addition, it showed the expected outcomes from these different methods.

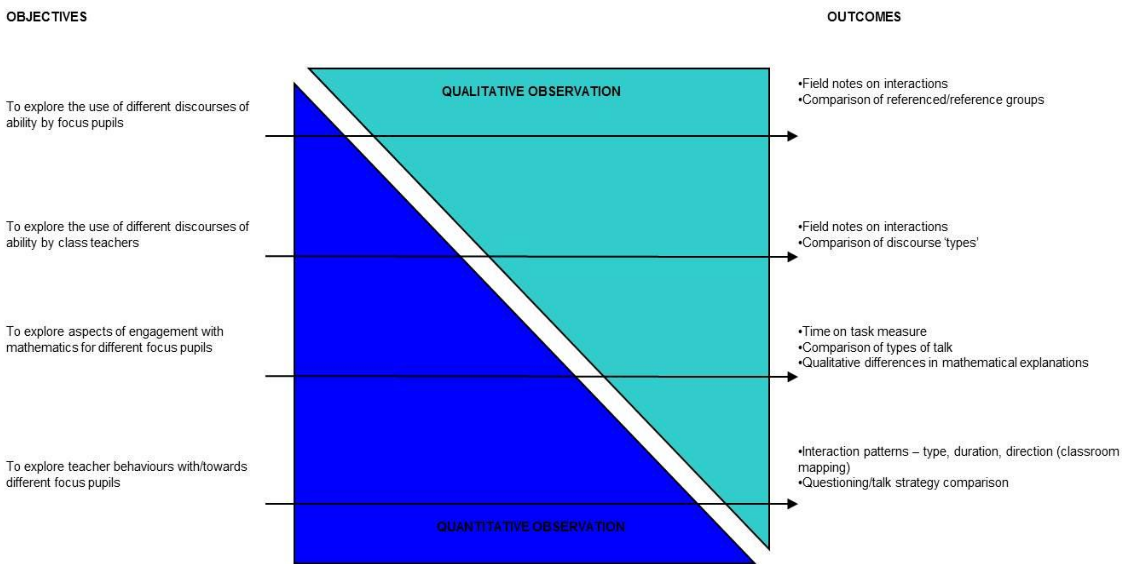


Figure 20: Combining quantitative and qualitative observation

The main data pilot collection methods were field notes and classroom mapping. Both were backed up by classroom audio recordings providing both quantitative and qualitative measures of classroom interactions. Classroom mapping was intended to track teachers' and TAs classroom behaviours in relation to pupils of different labelled abilities. It was designed to produce a visual representation of these interactions which lent itself to quantitative analysis and the possibility of triangulation with audio recordings and qualitative field notes of the same observations. One of the main hopes for this method was that it may have been able to explore possible disproportions in the quantity and quality of mathematical and behavioural interactions with differently labelled pupils.

Two types of mapping were used: teacher/TA movement and interaction mapping and teacher/TA initiated individual discourse mapping. Whilst the concept of classroom mapping has been used in other studies (e.g. Kutnick, et al., 2002), the method employed here was somewhat different. Both mappings involved the use of a classroom plan and were completed simultaneously during each lesson observation. With the movement and interaction mapping, the teacher/TA's physical location within the classroom was recorded at regular intervals during the lesson. Positions were marked with an interaction code indicating whether the teacher/TA was interacting with the whole-class, the individual or group they are located next to or an individual or group in another part of the classroom. The teacher/TA initiated individual discourse mapping worked on a similar principle. Key teacher/TA initiated individual or group interactions were recorded showing the group location of the pupil(s) involved and coded by type of interaction.

Various forms of audio recording were piloted. The majority involved a focal-pupil and the class-teacher being simultaneously audio-recorded using unobtrusive individual microphones. These could then be transcribed simultaneously giving a full transcript of the focal-pupil's interactions and allowing for clarity in teacher-pupil interactions within a transcript of the lesson observation. It was envisaged that these recordings and transcripts would allow the addition of detail to critical incidents noted in the field notes. Additionally, the recordings gave a possibility for quantitative data, for instance interaction lengths, to be taken from qualitative interactions.

Four objectives for this aspect of the piloting were produced to ensure that this stage of the study could be carefully evaluated and what was learnt from it brought into the design of the main study:

- To assess the feasibility of lesson observation as currently planned
- To assess the appropriateness of the proposed data collection for the requirements of the study

- To test the data collection methods of individual recording and the writing of field notes
- To explore the possibilities for analysis arising from the data collected

I produced a plan to pilot these different methods across six lesson observations conducted at Riverside Primary School:

Observation Number	Objectives	Data Collection Methods	Proposed Data Analysis
1	• Familiarise myself with the set/classroom environment • Produce classroom plans • Suggest potential areas/pupils of focus	• Field notes • Production of classroom plan	• Transcription of field notes • Listing of potential focus areas, points to note • Production of classroom plan for mapping and interviews
2	• Trial classroom mapping	• Classroom map	• Trial different methods of analysis for classroom map – visual, numeric, qualitative
3	• Trial teacher/pupil recording and field notes	• Field notes (high pupil focus) • Pupil and teacher recording (high)	• Transcription of field notes • Full transcription of recording for focus pupil and pupil/teacher interactions • Ongoing coding of transcriptions and reflections on usefulness
4	• Trial teacher/pupil recording and field notes	• Field notes (middle pupil focus) • Pupil and teacher recording (middle)	• Transcription of field notes • Full transcription of recording for focus pupil and pupil/teacher interactions • Ongoing coding of transcriptions and reflections on usefulness
5	• Trial field notes and classroom mapping	• Field notes (middle pupil focus) • Classroom map	• Transcription of field notes • Ongoing coding of transcriptions • Reflection of pros/cons of just field notes or field notes and recording • Application of trial methods to classroom map
6	• Trial teacher/pupil recording, field notes and classroom mapping	• Field notes (low pupil focus) • Pupils and teacher recording (low) • Classroom map	• Transcription of field notes • Full transcription of recording for focus pupil and pupil/teacher interactions • Ongoing coding of transcriptions and reflections on usefulness • Application of trial methods to classroom map

During piloting, I wrote notes on the ease of use for each method, and at the end of the six observations, evaluated the feasibility and suitability of the collection methods and their analysis. The mapping was found to be problematic from early on. Whilst it produced interesting data, this was too messy to have been of any real value, yet increasing the time intervals will have impacted on the reliability and hence validity of the method. An example of data emerging from this method is shown in Figure 21.

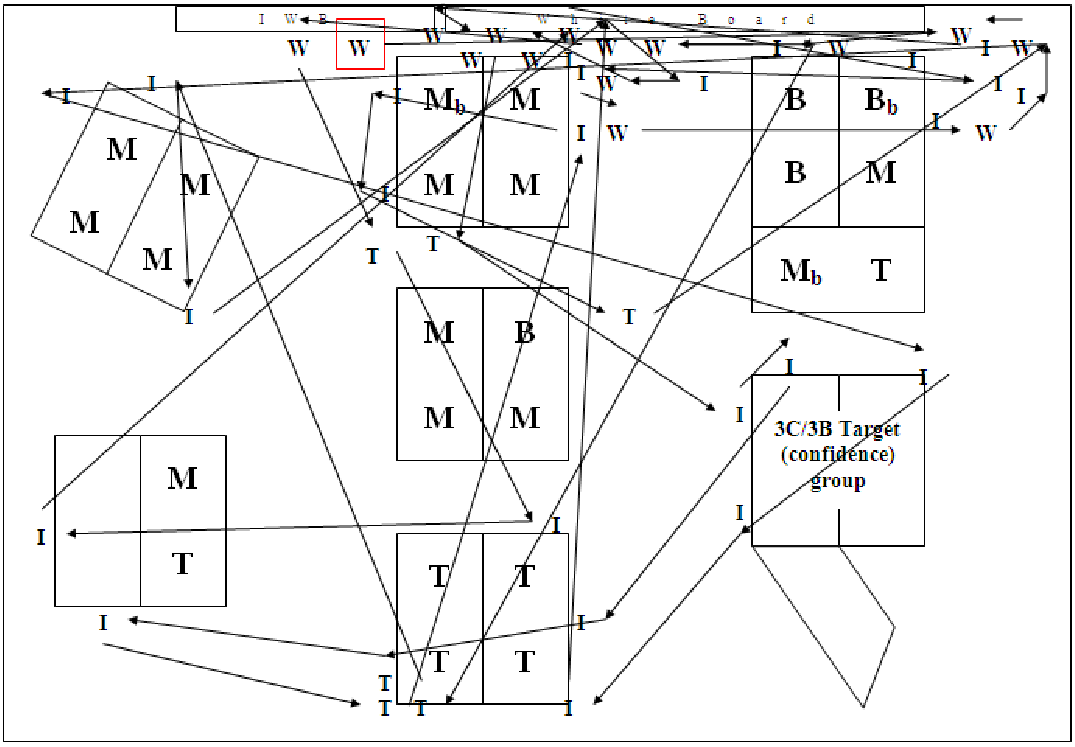


Figure 21: Classroom mapping example

I found it difficult as a lone researcher to utilize this instrument reliably alongside writing field notes. It was very difficult to take an entirely non-participant role in a primary classroom with pupils and the class-teacher interacting with me during the lessons. This may have resulted in me missing the recording of interactions at such regular intervals and hence impacted on the reliability of the instrument. On balance, the difficulties involved in collecting this data, in particular the possible negative impact on writing fieldnotes, outweighed the possibilities the method presented in terms of potential data collection. I decided within the main study not to use any mapping but to make the writing of field notes the basis of my observations.

The piloting of audio recording also proved to be essential and instigated changes in my research plan. Problems were envisaged in whether focal-pupils would be comfortable wearing individual microphones and whether wearing a microphone would change their usual classroom behaviour. This was not found to be the case, but problems were encountered in the use of the data gathered this way. Transcribing simultaneous (teacher and focal-pupil) audio recordings was time consuming, with individual transcriptions running to over 36 pages. At many points, I had to use my field notes to add contextualisation, as the audio-recording did not pick up any context or non-verbal communication. Comparing transcripts and field notes of the same lessons suggested that the fieldnotes alone provided richer data, particularly concerning classroom interactions, more suitable to addressing my research questions. As I was not conducting conversational analysis, it was felt that the detail produced in the audio transcripts was not required and did not add to the data in the field notes.

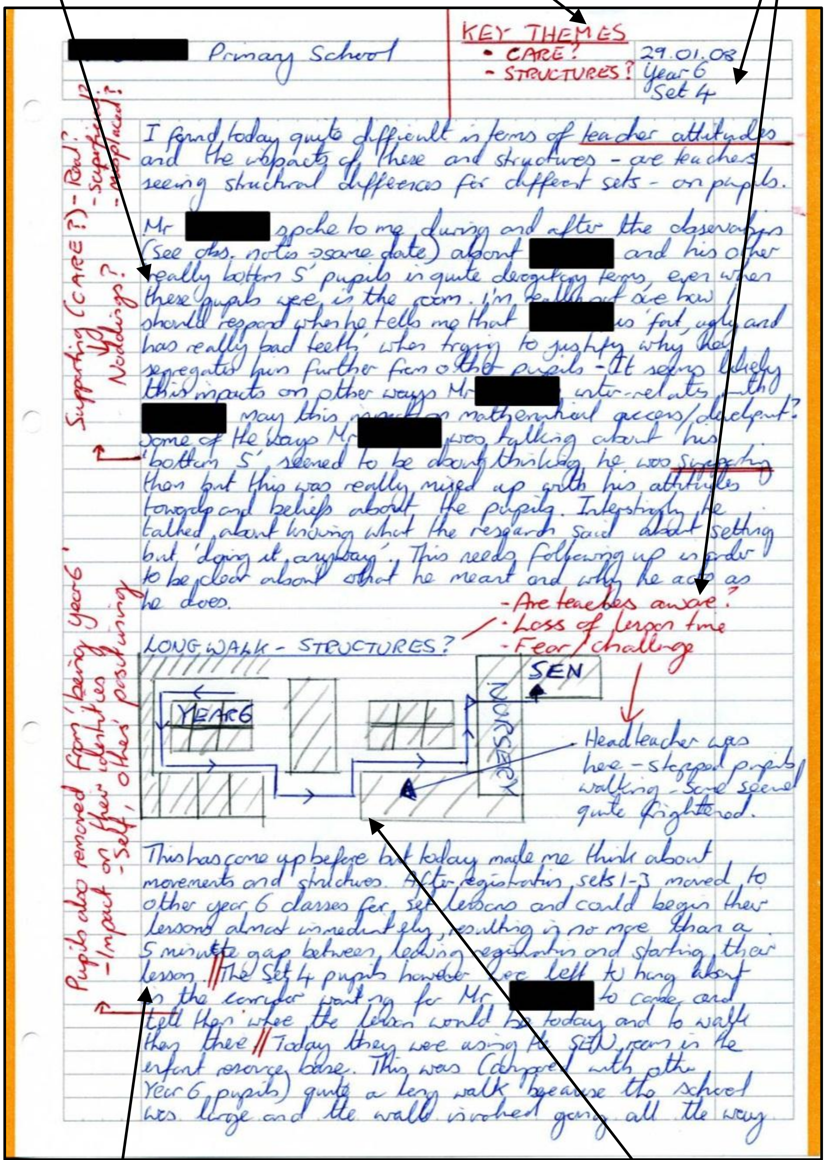
Given the issues encountered during the piloting of the observational research methods, I decided to focus solely on the use of annotated field notes within the main data collection.

Appendix H: Journal Notes and Incipient Theorising

I proposed possible issues that may be occurring and links with the literature to follow these up.

Key themes were identified from my journal entries and listed on each page as a quick reference – these also reflected the wider data coding.

Questions arising from my journal entries were listed. These were then followed up with other data relating to the same year group or set and across the data to see where the same questions were being asked.



[redacted] Primary School

KEY THEMES
• CARE?
- STRUCTURES?

29.01.08
Year 6
Set 4

Supporting (CARE?) - Real? - Superficial? - Misplaced?
Nodding?

I found today quite difficult in terms of teacher attitudes and the impacts of these and structures - are teachers seeing structural differences for different sets - on pupils.

Mr [redacted] spoke to me during and after the observations (See obs. notes same date) about [redacted] and his other 'really bottom 5' pupils in quite derogatory terms, even when these pupils were in the room. I'm really not sure how I should respond when he tells me that [redacted] is 'fat, ugly and has really bad teeth' when trying to justify why he segregates him further from other pupils - It seems likely this impacts on other ways Mr [redacted] inter-relates with [redacted] may this impact on mathematical success/development? Some of the ways Mr [redacted] was talking about his 'bottom 5' seemed to be about thinking he was supporting them but this was really mixed up with his attitudes towards and beliefs about the pupils. Interestingly he talked about knowing what the research said about setting but 'doing it anyway'. This needs following up in order to be clear about what he meant and why he acts as he does.

- Are teachers aware?
- Loss of lesson time
- Fear/challenge

LONG WALK - STRUCTURES?

YEAR 6
SEN
NURSERY

Headteacher was here - stopped pupils walking - Some seemed quite frightened.

This has come up before but today made me think about movements and structures. After registration, sets 1-3 moved to other year 6 classes for set lessons and could begin their lessons almost immediately, resulting in no more than a 5 minute gap between leaving registration and starting their lesson. // The Set 4 pupils however were left to hang about in the corridor waiting for Mr [redacted] to come and tell them where the lesson would be today and to walk them there // Today they were using the SEN room in the infant resource base. This was (Compared with other Year 6 pupils) quite a long walk because the school was large and the walk involved going all the way

Pupils also removed from 'being year 6'
- Impact on their identities
- 'Self, others' positioning

Additions were made to entries to reflect further thoughts that came up later and were potentially important.

Diagrams (and charts) were used within the journal and incipient theorising to make sense of observations and data and as part of the analysis process.

Appendix I: Observation Notes

LESSON OBSERVATION NOTES

Date	**Wednesday 30th January 2008**
Time	11:30am
School	Avenue Primary
Class	Year 4, Set 4
Teacher	Mrs [redacted]
Observation No.	LP_21_08.01.30
Special Notes	The two TAs usually working in this set were both absent today. Another TA had been moved from another year to work in the set today with the statemented pupil on 1 – 1 tasks away from the rest of the class. HA focal-pupil was absent. Observation focussed on MA and LA pupils. I sat next to LA pupil. The lesson was conducted in a Year 3 classroom.

Lesson Context (Objectives etc.): To begin to use column addition (objective on board) – the day before the pupils had been taught by a supply teacher who had covered some of the same material.

Prior to Lesson

The pupils did not have a stable classroom base for the lesson. Over break-time, Mrs [redacted] negotiated with a Year 3 teacher to use her classroom as the Year 3 teacher was using the computer room for that lesson.

At the beginning of the lesson, most of the Set 4 pupils were hanging around outside Mrs [redacted]'s classroom. Mrs [redacted] came carrying large trays of cubes and asked the pupils to carry these to Year 3 for her. One pupil told Mrs [redacted] the SEN pupil was missing – Mrs [redacted] went to look for her whilst I went with the Set 4 pupils over to the Year 3 classrooms. Mrs Massey came to the classroom with [redacted] and the TA working with her today – they had gone to the science room which the set often used for their lessons.

Pupils appeared to be allowed to choose where they sat, although Mrs [redacted] moved some pupils. [redacted] was working with the TA at the back of the classroom and was not part of the lesson.

Lesson Starter

Mrs [redacted] begins by telling the pupils they are going to be rounding numbers to the nearest multiple of 10.

She writes on the board:

$$\xrightarrow{\text{ROUNDS TO}}$$

She explains to the pupils that they can use the arrow so that they don't have to write because they don't want to be doing lots of writing.

The teacher asks the pupils how they can recognise multiples of 10. 3 pupils have their hands up but Mrs [redacted] doesn't go to any of them suggesting that they will have to try counting in 10s. The class count forwards in 10s (slowly) from 10 – 100 using a counting stick.

This is repeated several times, always starting at 10 (not zero) and always finishing at 100. Afterwards, the teacher again asks the pupils how they can recognise multiples of 10. She asks [redacted] who had his hand up originally – he replies that they end in zero – the teacher replies "yes" but does not extend this further.

Mrs [redacted] then writes 32 on the board. Using a numberline above the board, she demonstrates that this is closest to 30 and writes down:

32 → 30

She then writes some further questions on the board and asks the pupils to do these on their individual whiteboards:

47 →

55 →

26 →

15 →

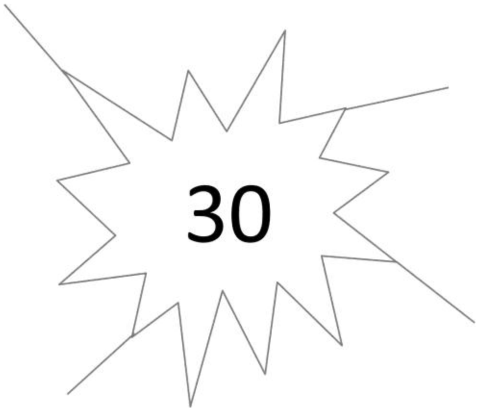
91 →

83 →

65 →

When they have finished she asks them to rub out their answers (there is no discussion or correction of answers and Mrs [redacted] has not looked at pupils' work. I have seen some mistakes on pupils work and it appears that the pupils weren't sure what to do with 55, 15 or 65).

The teacher then writes on the board:



She says she is challenging the pupils to find all the numbers that round to 30. She asks [redacted] (HA labelled pupil in Set 4) if he can give all the answers. She explains to the class that she is asking [redacted] to do the challenge because he was the first to finish the other task. The other pupils are not involved in the task. When going through the answers on the board, the teacher explains procedurally that when a number ends in 5 it is rounded up.

Main Task:

Mrs [redacted] explains that they will be re-using and extending the work they have started on column addition. [redacted] asks if they can do them with thousands and [redacted] asks excitedly if they can do millions. The teacher replies that they can't because she doesn't want them to rush on and make mistakes. Instead she says they are going to be learning to do column addition in a different way.

The teacher writes 47 + 32 = on the board. She begins by getting the pupils to round the numbers to get an idea of the answer. The pupils are working through the addition method on the board. The teacher uses extensive funnelling to prompt [redacted] to say 80 but having given the teacher what she wants to hear he adds to it, very tersely, that he wants to do questions with millions. The teacher replies "Can we please not fuss about millions and thousands because we are not going to be doing them; we are doing tens and units which we can do and need to be doing".

Mrs [redacted] then goes back to column addition and does not mention rounding again.

The teacher goes through the sum vertically, setting it out as:

47	40 + 7
32 +	30 + 2
	70 + 9

She talks about shrinking the 40 to 4 to make it 4 + 3. She then combines the numbers 70 and 9 to give an 'exact' answer of 79. She then goes on to say that today they are going to learn to do this in a quicker way in order to save time. Some pupils are calling out or saying to themselves that "they know".

The teacher goes through the same question in the new way:

47
<u>32 +</u>
70
<u> 9</u>
79

She again refers to the 40 + 30 as 4 + 3 and holds up 4 cubes and 3 cubes, putting them together to make 7 cubes, before writing 70. She then holds up 7 cubes and 2 cubes putting them together to make 9 cubes. Having worked through this example once at a slow pace, the teacher goes through it again at an even slower pace. It is clear that most of the pupils have switched off and are bored – some are told off for not listening.

In talking through the method a second time, the teacher asks the pupils if they can remember what "the line" is for. I am unclear what answer she is expecting. She chooses [redacted] (he doesn't have his hand up) and asks him if he knows what the line is. Quite angrily, and through gritted teeth, [redacted] answers, "no, because when we did it yesterday, Mrs [redacted] gave me one in the thousands to work through." [redacted] appears to be seething, seeming really cross at going back to two digit addition.

The teacher then goes through it again, this time the pupils are asked to copy it on the whiteboards. Some pupils copy the whole thing quickly without following the teacher's steps. Others (including [redacted]) do not make any attempt to copy, either doing nothing or drawing on their whiteboards.

The pupils are then given five questions written on the board for them to work through in their books. They are told that it is important that they set these out correctly and they are given piles of cubes on each table and are told they must "use these to check your sums".

During the pupil task, most pupils seem to be working through the questions, although they are approaching them in different ways. Some are missing out the middle step and going straight to the column addition algorithm – I wonder if they have been taught this elsewhere. Other pupils are seen using cubes for the whole sum, i.e. counting out 34 cubes then another 21, then counting them all. A number of the pupils seem to have problems copying the questions off the board, and so many pupils are answering different questions.

34	56	27	43	57
<u>21 +</u>	<u>13 +</u>	<u>22 +</u>	<u>34 +</u>	<u>32 +</u>

[redacted] is working on the question 57 + 32 = He has set this out vertically as required. [redacted] seems confident that he knows 7 + 2 and 5 + 3 without the need for cubes and so he has worked through the questions fairly quickly, and apparently more quickly than expected by Mrs [redacted]. When he tells her he has finished he is asked to check each one with the cubes. [redacted] does not appear too happy with this response, does not check his answers by any means but instead uses his cubes to build a light-sabre which he uses to silently 'attack' (without physical contact) [redacted]. Mrs [redacted] notices this behaviour and instantly chastises him, saying "that is not what we use the cubes for" and tells him that he needs to get on with his maths. [redacted] does not do any further maths work during the lesson, playing with his cubes instead and looking angrily at the teacher when she looks at what he is doing.

End of Lesson

There is no plenary. At the end of the lesson (lunchtime), Mrs [redacted] asks the pupils to close their books and wipe their whiteboards and to pack away quickly. The pupils are then dismissed apart from [redacted] who she asks to stay behind. Mrs [redacted] tells [redacted] that he needs to understand and use her method and asks him to sit and think about it so he misses part of his playtime. He now seems very angry telling Mrs [redacted] that she should let him use thousands and bigger numbers. Mrs [redacted] ignores this and dismisses him after 10 minutes.

Appendix J: Pupil Personal Construct Theory Interviews

Interview Objectives

Individual Interview Objectives

- To explore the nature of pupils' use of ability language
- To explore how pupils produce, reproduce and transform ability
- To explore pupils' application of their understanding of ability to themselves
- To explore pupils' engagement with mathematics
- To explore pupils' orientations towards mathematics
- To explore pupils' beliefs about success in mathematics

Group-Interview Objectives

- To explore how groups of pupils work together to produce, reproduce and transform ability
- To explore how pupils perceive differences in the treatment of different pupils
- To explore issues of within and between classroom grouping – how, why and effects

Teacher Interview Objectives

- To explore the nature of teachers' understanding of ability
- To explore how teachers produce, reproduce and transform ability in primary mathematics
- To explore how teachers talk about ability in relation to their own educational/life histories and the impacts of this on their current use of ability
- To explore teachers' orientations towards thinking about and teaching mathematics
- To explore teachers' beliefs about success in mathematics

Personal Construct Theory

Constructs come from the psychological base of Kelly's (1955) Personal Construct Theory (PCT). This is based on the premise that individuals build up an understanding of themselves and others through the unconscious application of dichotomous elements such as happy or sad, with each representing a construct. In being built on dichotomous elements, constructs become a label for the way some things are alike and yet different from other things.

The philosophical roots of PCT lie in constructive alternativism (CA). This believes that we need to understand that every person views life events in their own way and that there are always alternative constructions available. In order to make sense of the world around us, we try to fit these constructs to the realities of the world. We then alter or completely change these constructs to produce a better fit with reality. Whilst my study is grounded in critical realism and not in constructive alternativism, using PCT is justifiable in that I am only taking a method from PCT, something CR encourages, as opposed to embracing the psychological or CA philosophical bases. Further, there are a number of congruencies between CA and CR. CA and Kelly's approach rely on a belief that the world exists independently of our thoughts and that we come to know this real world through the application and development of our constructs. Such independent existence fits within a realist paradigm. A belief that we can only come to understand this world through placing our interpretations on what we see (Kelly, 2003), particularly the assumption that interpretations can be changed or replaced and that some constructs may be better (Kelly, 1955), fits the CR concept of judgemental rationality. Further, Kelly's understanding of the world takes it to be in a continual state of change fitting CR's concepts of reproduction and transformative reproduction. Whilst not truly identical, CR and CA share enough common ground that it is defensible to take a PCT method within a CR study. Additionally, Kelly expected his theory to be used as a suggestion for practice and in doing so actively encouraged practitioners to discard aspects that were not useful (Denicolo, 2003). Other educational researchers have adapted the PCT method to their own needs (e.g. Blease, 1995) as I have, corresponding with CR's approach to method selection.

The main instrument of the psychology of personal constructs is the Role Construct Repertory Test (Rep Test). Kelly produced eight different forms of the Rep Test and further suggested that each could be varied. The basic procedure for the test involves individuals sorting person name cards and discussing the relations between them in terms of constructs. Working with groups of three names, individuals name an important way in which two of the named people are alike but different from the third person. The label the individual applies to this third person is recorded as a personal construct. In the self-identification form of the Rep Test, the same procedure is applied, but one of the person name cards is labelled 'myself'.

Interview Schedule

I want to talk to you about your experiences of learning maths. I would like to record our conversation so that I can remember what we have talked about, but I won't tell anyone who knows you, including your teacher, what you say. Our conversation will last about 20 minutes. Are you happy to continue?

Perceived Ability Task

Have a look at this line. It goes from people who are best at maths to people who are worst at maths. We can put people anywhere on this line (give examples).

1. I want you to think about three children in your year that you know well. Can you stick labels with the first letters of their names on the line to show where they would be?
   - Can you tell me how you decided to put [highest initial] there?
     - What are they like in maths lessons?
   - Can you tell me how you decided to put [lowest initial] there?
     - What are they like in maths lessons?
   - Can you tell me something that is similar about [top two initials] but different from [bottom initial]?
   - Can you tell me something that is similar about [bottom two initials] but different from [top initial]?
   - Can you tell me something that is similar about [top and bottom two initials] but different from [middle initial]?

2. If I asked your teacher, where would he/she put you on this line – can you stick on this green label to show me?
   - Why do you think your teacher would place you there?
   - How does your teacher decide how good children are at maths?

3. Now, can you stick this blue label on to show me where you think you actually are?
   - How do you know how good you are at maths?
   - Now you've put yourself [higher/lower] than where you think your teacher would put you – why is that?
   - Could you make yourself better at maths? How?
   - Could you become worse at maths? How?

4. Can you think of a child in your year that would be here [best at maths]?
   - How do you know they would be there?
   - What are they like in maths lessons?
   - What sort of maths tasks do they like to do?
   - What is their teacher like towards them – why do you think he/she is like this?

5. Can you think of a child in your year that would be here [worst at maths]?
   - How do you know they would be there?
   - What are they like in maths lessons?
   - What sort of maths tasks do they like to do?
   - What is their teacher like towards them – why do you think he/she is like this?

6. People can be in different places on this line:
   - What do you think makes someone do well at maths?
   - What do you think makes someone do not so well at maths?

Feelings Tasks

1. Can you tell me about how you feel in maths lessons?

2. Can you draw that in for me? – you can add a thought bubble to show why you feel like that

3. Can you tell me about your drawing?
   - How are you feeling?
   - Why? – What makes you feel like that?
   - Do you think other children feel the same? – Who?/Why?
   - Do you always feel like that in maths?
   - When might you feel different?

4. What makes you pleased in maths lessons?
   - Type of lesson
   - Ways of working
   - Assessment
   - Organisation
   - A time you've felt really pleased

5. And what might make you not pleased in maths lessons (prompts above)?

Classroom Arrangements

Here I have a plan of your maths classroom. [Explain some details to help orientate pupil.]

1. Can you write your name to show me where you sit?
   - Why does your teacher sit you there?
   - How do you feel about sitting in that place?
   - Have you always sat in the same place?
   - Why did your teacher move you [or why doesn't he/she move you]?
   - Where would you like to sit?

2. How does the teacher decide who sits where? [Follow-up]

3. If a new child came into the class, how would your teacher decide where to sit them?

4. Where would you sit different children in the classroom of you had the choice?

That's the end of my questions. Is there anything else you would like to say about your maths lessons?

Interview Tasks

Perceived Ability Task

The perceived ability task represented the PCT aspect of the interview. It also served to validate the perceived ability item in the attitudinal questionnaire. During this task, pupils were presented with a blank line ranging from 'best in maths' to 'worst in maths' which was the same as the line they had previously encountered in their questionnaires. This line was printed on A3 paper. This ensured that there was space for pupils to stick their labels on, whilst still being manageable (see Figure 22).

They were asked to think of three children they knew well in their year at school. No further guidance on selection was given as it was important they made an independent choice in order to ensure the production of valid constructs. They were given sticky dots with letters on and were asked to put the first letter of each of the three children they had selected on the line to show where they thought they would be. PCT questioning was used to elicit the focal-pupils' constructs in thinking about these three pupils and how each one differed from the other two. Applying aspects of the self-identification Rep Test, pupils were then asked to put a blue dot on the line to represent themselves. Further, and moving away from the PCT techniques, they were asked to put a green dot on the line to indicate where they thought their teacher would place them; this item was important in exploring the different influences on pupils' constructions.

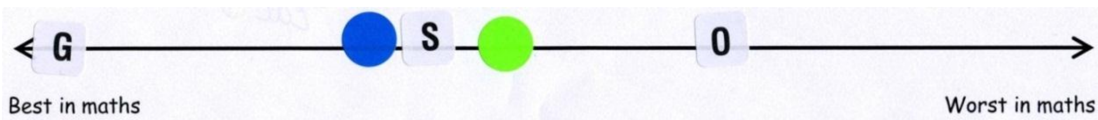


Figure 22: Pupil PCT interview – perceived ability task

Feelings Task

The feelings task represented an extension of questioning in my earlier study and brought in items from the attitudinal questionnaire. In this task pupils were first asked about how they felt in mathematics lessons to elicit responses on a general level. They were then presented with a picture representing a mathematics classroom similar to their own.

Different images were used as appropriate and these were all random images and not of the pupils' schools (see example in Figure 23, these were presented in full colour).

Pupils were asked to draw in their face to show how they felt in maths lessons. They were then asked to show the things they thought about during mathematics lessons in the thought bubble. Pupils were provided with pencils and felt-tips and were encouraged to write and/or draw as they felt comfortable. These drawings were then discussed with prompts included in the interview schedule. Data from this task could be triangulated with the orientations questionnaire items having an 'I feel pleased when' stem. In responding to a concern with the attitudinal questionnaire that all items are worded positively, pupils were also asked about when they have not felt pleased in order to produce more balanced data.

Figure 23: Pupil PCT interview – feelings task

Classroom Arrangements Task

During my early visits to the schools, I produced scaled diagrams of each mathematics classroom (see example in Figure 24). Table labels/names were purposely excluded in order to ascertain pupils' awareness of these. The diagram was explained as necessary to help pupils orientate themselves and pupils were then asked to mark on the plan where they sat. Pupils were able to write or draw on the plans or colour tables/groups as appropriate. They were then asked to talk about why they thought they were sat there and what they thought were the teachers' reasons for sitting them there. This question was also asked in terms of the placement of a new pupil to the class in order to explore the extent to which individual pupils' reasoning was specific to themselves or a more general construct. The same plans were used in the group-interview task. This ensured all pupils were comfortable with interpreting the plan in the individual interview before discussing it together in groups.

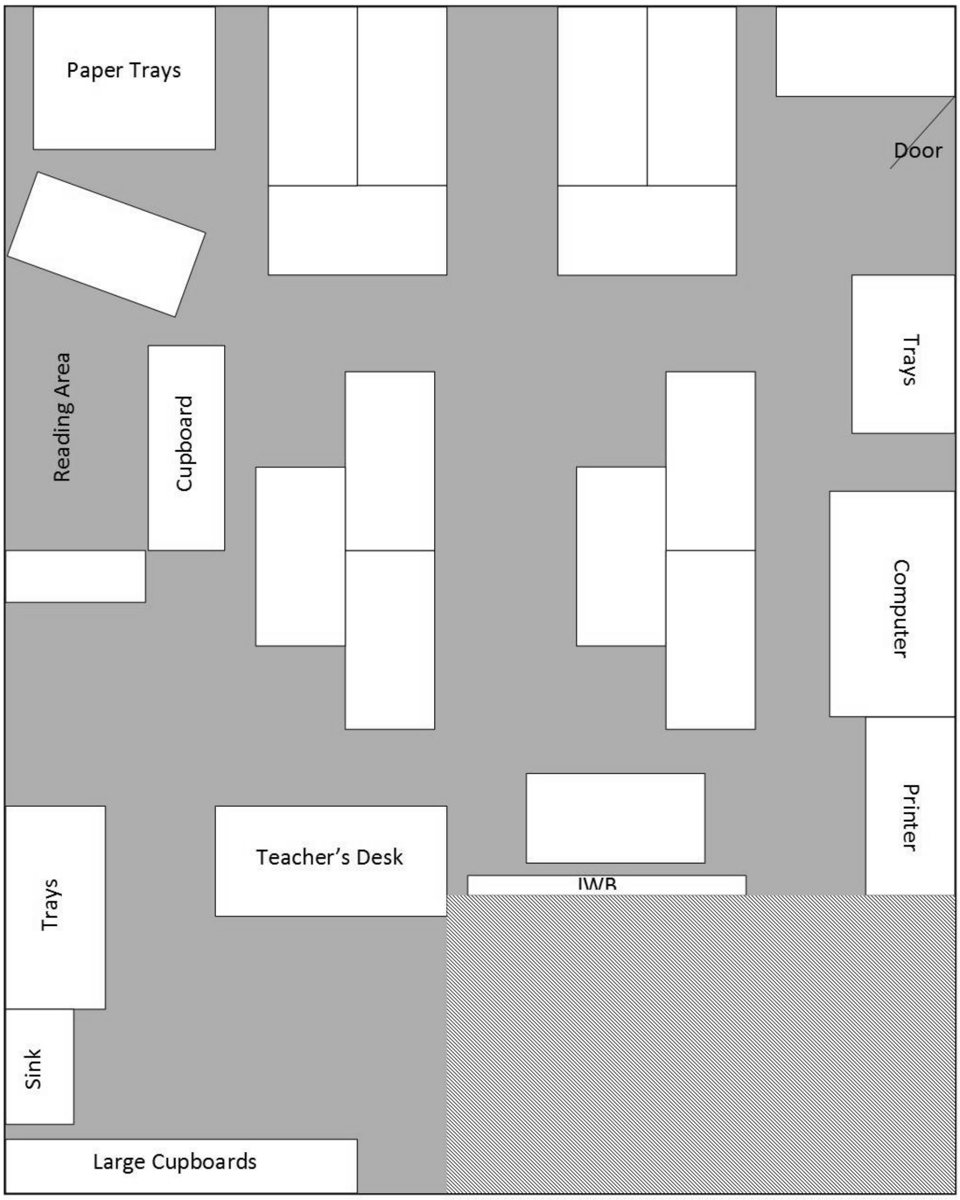


Figure 24: Pupil PCT interview – classroom arrangements task

Appendix K: Pupils' Group Interviews

Interview Schedule – Year 6

I want to talk to you about learning maths. I'm most interested in what you all think about your maths lessons. It'll take about 20 minutes. I'll record the conversation and write some things about what you say so I can remember it, but I won't tell anyone what you say.

A. SETTING: I want to talk to you about the classes you are in for maths. Other children I've talked to have been put into different classes or sets – is that what happens here?

1. What can you tell me about this?
2. So what does setting mean?
3. Why have different sets?
4. What's good / what's bad?
5. What would it be like without sets – Good / Bad things?
6. How do the teachers decide which set to put different children in?
   - Assessment
   - Levels
   - Behaviour

   and follow up (meaning, how they are worked out …)
7. Which set are you in?
   - What does being in your set mean about you?
   - What does being in your set mean about how well you do in maths?
   - What sort of people are in this set?
8. And the other sets?
   - What sort of people? – working, how they learn, behaviour
   - What sort of maths?
   - What would be good/bad about being in that set?
9. Does anyone change sets?
   - Who / When / Why?
   - Would you like to change? Why?
10. What about grouping in class?
    - How? / Why? / Good? / Bad?
    - Is it important to be grouped?
    - How would you most like to be grouped?

B. MATHS LESSONS

1. What do you like most about maths lessons?
   - Why?
2. What do you like less?
   - Why?
3. What would really good maths lessons be like?
   - Class arrangements – groups, individuals …
   - Teacher
   - Other pupils
   - Type of work
   - Pace, traditional/reform
   - Assessment

C. SATS and being a Y6 pupil: I want to finish by talking to you about what is special about year 6.

1. In what ways are year 6 maths lessons different from other years?
   - Follow-up – How, Why, what's the same
   - Assessment
   - Teaching methods – pace, type of work, group/pair, individual
2. SATS
   - Why do you think you have SATS?
   - What do the SATS marks mean – how important are they?
   - How do you feel about doing your SATS? – Why?
   - Are SATS a good idea? – Why (not)?
3. Secondary Schools and mathematics
   - What do you think maths lessons will be like in secondary school?
   - How will they be different from primary – setting / pace / teaching / tasks?
   - What are you looking forward to about maths in secondary school?
   - What are you not looking forward to?

Thank You. That's the end of my questions.

Is there anything else any of you would like to say about your maths lessons?

Interview Schedule – Set Year 4

I want to talk to you about learning maths. I'm most interested in what you all think about your maths lessons. It'll take about 20 minutes. I'll record the conversation and write some things about what you say so I can remember it, but I won't tell anyone what you say.

A. SETTING: I want to talk to you about the classes you are in for maths. Other children I've talked to have been put into different classes or sets – is that what happens here?

1. What can you tell me about this?
2. So what does setting mean?
3. Why have different sets?
4. What's good / what's bad?
5. What would it be like without sets – Good / Bad things?
6. How do the teachers decide which set to put different children in?
   - Assessment
   - Levels
   - Behaviour

   and follow up (meaning, how they are worked out …)
7. Which set are you in?
   - What does being in your set mean about you?
   - What does being in your set mean about how well you do in maths?
   - What sort of people are in this set?
8. And the other sets?
   - What sort of people? – working, how they learn, behaviour
   - What sort of maths?
   - What would be good/bad about being in that set?
9. Does anyone change sets?
   - Who / When / Why?
   - Would you like to change? Why?
10. What about grouping in class?
    - How? / Why? / Good? / Bad?
    - Is it important to be grouped?
    - How would you most like to be grouped?

B. MATHS LESSONS

1. What do you like most about maths lessons?
   - Why?
2. What do you like less?
   - Why?
3. What would really good maths lessons be like?
   - Class arrangements – groups, individuals …
   - Teacher
   - Other pupils
   - Type of work
   - Pace, traditional/reform
   - Assessment

C. MATHS TASKS: We talked a bit about maths work in different sets. I've got some different year 4 maths tasks here.

1. Most mathematical?
   - How is it different from the other tasks?
2. Least mathematical?
   - How is it different from the other tasks?

Thank You. That's the end of my questions.

Is there anything else any of you would like to say about your maths lessons?

Interview Schedule – Mixed-Ability Classes Year 4

I want to talk to you about learning maths. I'm most interested in what you all think about your maths lessons. It'll take about 20 minutes. I'll record the conversation and write some things about what you say so I can remember it, but I won't tell anyone what you say.

A. CLASS ARRANGEMENTS: I want to begin by talking to you about how you are sat in class for your maths lessons.

1. What can you tell me about this?
2. How do the teachers decide where to sit different children?
   - Assessment
   - Levels
   - Behaviour

   and follow up (meaning / how they are worked out …)
3. Why do you think you are organised like this?
4. What's good / what's bad?
5. What would it be like if you weren't organised like this – Good / Bad things?
6. Where abouts do you sit?
   - What does sitting in these places mean about you?
   - What does sitting in these places mean about how well you do in maths?
7. Is it important to be grouped in class?
8. How would you choose where children sat if you had the choice?
   - Why?
   - What would be better about this?

B. MATHS LESSONS

1. What do you like most about maths lessons?
   - Why?
2. What do you like less?
   - Why?
3. What would really good maths lessons be like?
   - Class arrangements – groups, individuals …
   - Teacher
   - Other pupils
   - Type of work
   - Pace, traditional/reform
   - Assessment

C. MATHS TASKS: We talked a bit about maths work for different children. I've got some different year 4 maths tasks here.

1. Most mathematical?
   - How is it different from the other tasks?
2. Least mathematical?
   - How is it different from the other tasks?

Thank You. That's the end of my questions.

Is there anything else any of you would like to say about your maths lessons?

Group Interview Tasks

Classroom Arrangements Task

This task was predominantly used with Year 4 pupils at Parkview, but was also included with Year 6 pupils at Parkview after observations suggested these pupils to be table-grouped by ability within their sets. The same classroom plans as used in the individual interviews were used, although the tables were removed and presented as separate rectangular blocks of card to the correct scale (Figure 25)

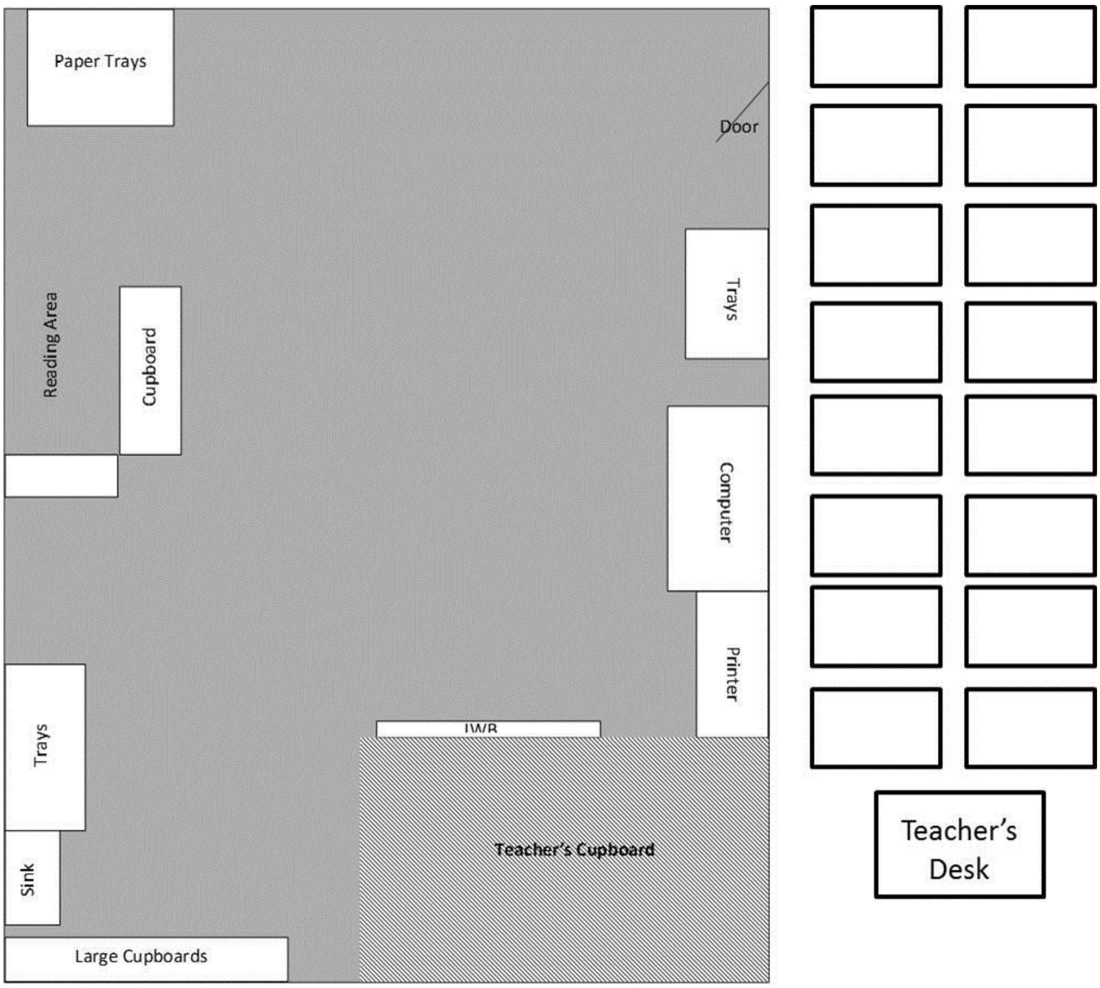


Figure 25: Pupil group interview – classroom arrangements task

Pupils were able to move around and stick the blank tables onto the plan whilst discussing how they would arrange the classroom. Other classroom furniture was kept in the plan to ensure the focus was on where the pupils sat, rather than on the classroom layout as a whole. Pupils were able to write on or colour the tables to indicate any labels or groups they would assign to each table.

Maths Task Cards

After revisiting the best-worst at maths line and discussing pupils at both ends, the groups were presented with a selection of maths task cards all taken from Year 4 material. These were all A5 in size and strongly laminated to allow pupils to slide them around the table during discussion. These maths tasks were carefully selected to represent a range of topics, methods, pictorial, written and numerical presentations whilst retaining overlap between particular cards in terms of content. Pupils were asked to select tasks that they felt were most and least mathematical, to discuss why they thought this, and who they thought each task would be most suitable for (based on line positions). PCT style questioning was introduced with other cards as a comparative to explore pupils' constructs further.

Year six pupils did not complete the maths card sorting task. One rationale for this was the wide attainment range and different tasks the pupils engaged with in class making it difficult to select a set of task cards understandable to all pupils but not immediately introducing notions of difficulty.

Illustrations of the task cards are given below and on the following page (Figure 26 and Figure 27).

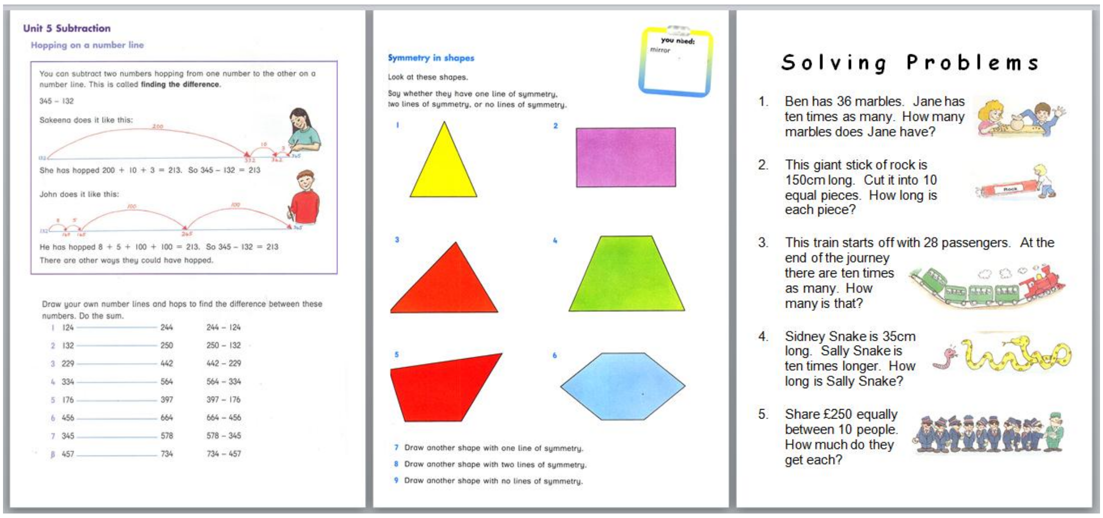


Figure 26: Pupil group interview – maths task cards

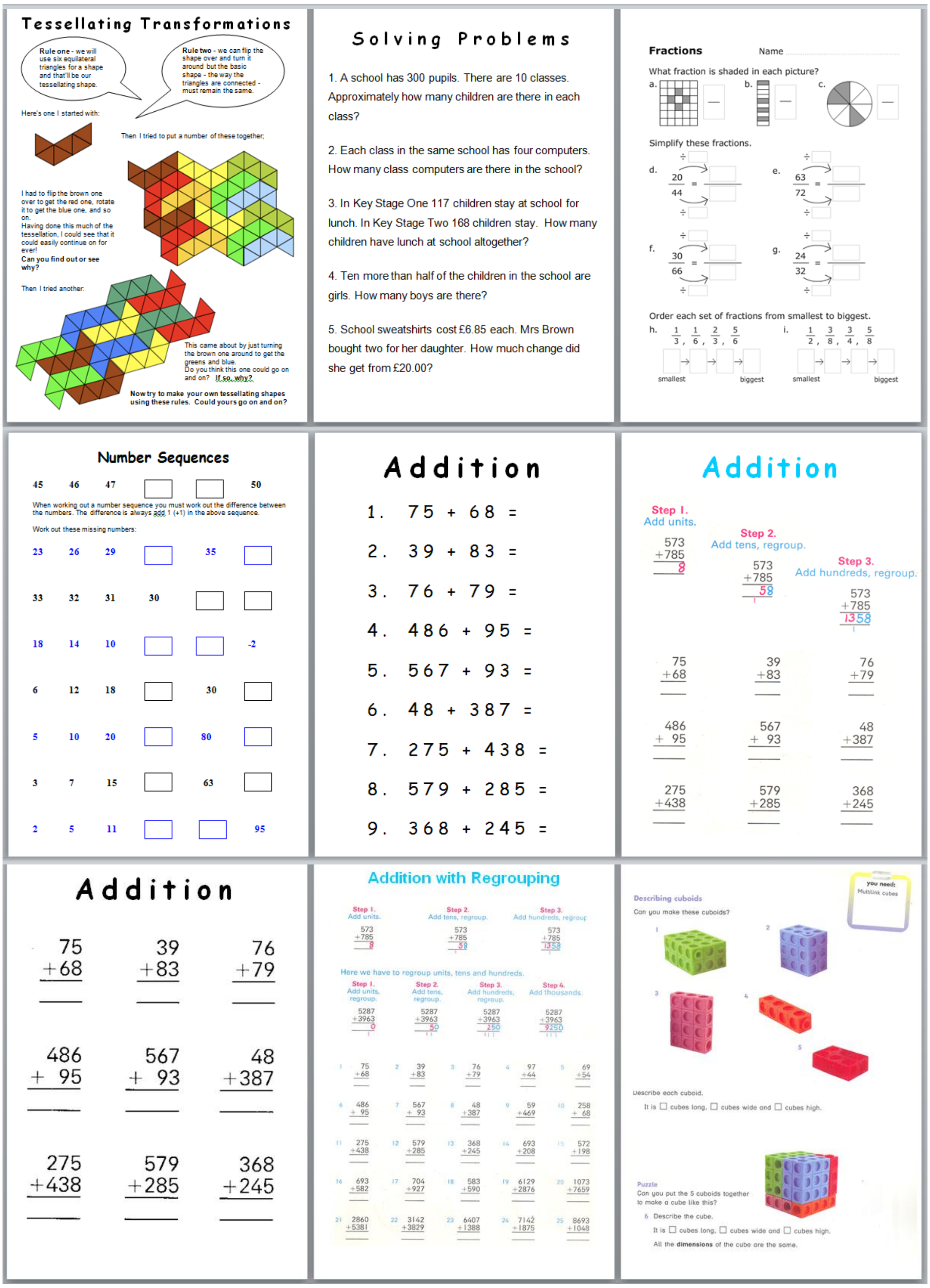


Figure 27: Pupil group interview – maths task cards (continued)

Follow-up Group-Interview Tasks

Statement Cards

The pupils were presented with 17 statement cards (Figure 28), each giving a reason for doing well in mathematics lessons. Each of these reasons was taken from the full set of pupil individual interviews, tying in with the data analysis here in representing a number of the coding categories. Blank cards were included for pupils to add any further statements they felt necessary. The statements were presented as large laminated cards in no particular order. The source of the statements was explained to the pupils and they were then asked to order them, as a group, from the most to the least important. A similar task was used in my MRes study, although here the statements had been taken from the literature rather than pupils' own words. As pupils placed the cards, they were asked to talk about and justify their decisions. Where there were differences of opinion within the group, pupils were asked to discuss each and to come to a unanimous decision.

Doing what the teacher asks you to do
Trying to get more answers right than others
Trying to do more work than other children
Trying to forget about other things that are worrying you
Being cleverer than the other children

Having neat work
Being interested in learning maths
Working really hard
Enjoying doing maths
Being quiet in maths lessons
Being happy
Listening to the teacher
Paying attention in the maths lesson
Having more ability to learn
Behaving well in lessons
Always doing your best
Doing well in maths tests

Figure 28: Pupil follow-up group interview – statement cards task

Quotes Cards

Within this task I explained to the groups that I needed some help in understanding what children had said to me in other interviews. I presented them with two sets of cards (Figure 29), each with quotes from previous interviews and asked them to discuss the interview quotes, exploring what they thought they meant and how people could have such different opinions.

"Most children think they're really bad at maths"

"Most children are really good at maths"

"All children can do really well in maths if they try really hard"

"Only children who have lots of ability can do really well in maths"

Figure 29: Pupil follow-up group interview – quotes cards task

Appendix L: Teachers' Personal Construct Theory Interviews

Interview Schedule and Task

Perceptions of being good/bad at maths

Teachers were presented with a similar version of the Personal Construct line used in pupil interviews and the pupil questionnaire (Figure 30). The teacher line was A3 in size and laminated to allow them to move the positions of pupils during the discussion if they felt this was necessary.

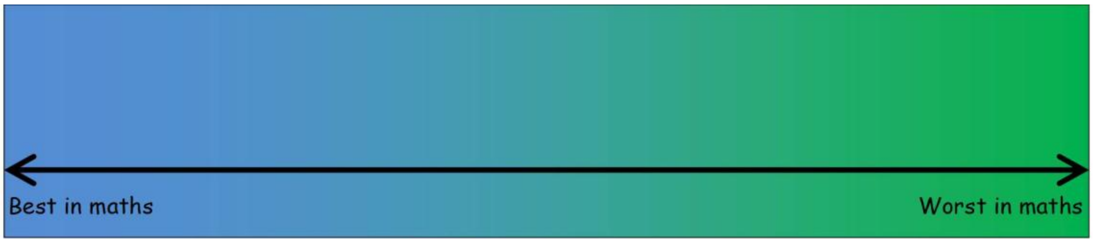


Figure 30: Teacher PCT interview – pupil placement task

Personal construct task – Focal-pupils on best to worst line (line represents year group)

1) Can you tell me how you decided to put [highest] there?
   a) How would you describe them in a typical maths lesson?
   b) Repeat:
      i) Lowest
      ii) Middle

2) Can you tell me any things that are similar about [top two] in their approach to maths and maths lessons that are different from [bottom one]?
   a) Repeat for bottom two/top one etc.

3) What makes someone good/best at maths?
   a) What would a pupil who was here [best end] on the line be like?
   b) What does being good at maths mean to you?

4) What makes someone worse at maths?
   a) What would a pupil who was here [worst end] on the line be like?
   b) What sort of things result in lower achievement?

5) How much difference can schooling make to how good a pupil is at maths?
   a) What affects how good someone is at maths?
   b) How much opportunity is there to get better at maths?

6) In what ways is being good at maths different from being good at other subjects?
   a) What would you expect a pupil who is good at maths to be like in other subjects?
   b) How is being good at English/Literacy different to being good at maths?

Assessment

1) What kinds of information do you use to decide how well a pupil is doing at maths?
   a) Which to you find most useful?

2) Which do you use most often?

3) What's different about the information you get on pupils from different types of assessment?
   a) Which would you trust more?

4) How important is it to know pupils' NC levels?
   a) How much trust do you place in this information?
   b) How do you use it in your planning and teaching?

Setting and grouping

1) What do you use in setting/grouping placements?
   a) Who decides on this policy?
   b) What other types of grouping are used?
      i) What are the advantages of different types of grouping?
      ii) Disadvantages?

2) Have you always taught to setted/un-setted classes?
   a) What are (or do you envisage are) the benefits to setting:
      i) for teachers
      ii) for pupils
   b) What about disadvantages:
      i) for teachers?
      ii) for pupils?

3) What different teaching strategies would be appropriate for a lower set/group?
   a) And for a higher set/group?

4) What guidance have you had in responding to pupils with a range of needs?
   a) What has been most useful?
   b) What has been least useful?
   c) What would be useful to help you respond to different pupil needs?

Thank You. That's the end of my questions.

Is there anything else any of you would like to add?

Appendix M: Interview Transcripts

Pupil PCT Individual Interview (full transcript)

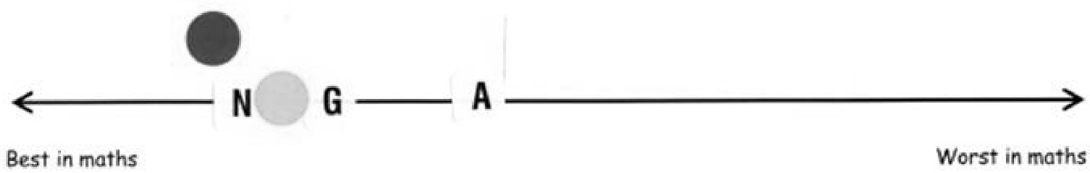
INDIVIDUAL PUPIL INTERVIEW

Date	**Tuesday 27th November 2007**
Time	11:36am
School	Parkview Primary School
Class	Year 6, Set 1
Focal Pupil	MA
Pupil No.	261020
Pupil Pseudonym	Ben
Interview No.	13
Special Notes	

Rachel: What I'd like to do is talk to you about your maths lessons, we're going to do some tasks together, but not do any maths. Now I'd like to start with this line, you've seen this before haven't you. I want you to think of three children you know in year 6 and put the first letter of their name on to show me where they go.

Ben: In my maths group?

Rachel: Anyone in year 6 at Parkview.



Ben: Okay, Nabiha, he's there, Gaby, she's there and Aymil.

Rachel: Let's start with Nabiha, how do you know he's there?

Ben: Because I sit next to him in my maths group and he's quite good at working out maths stuff and we make a good team. I know he's good because I've been sitting next to Nabiha for the past two months in my maths group and I can see that he's quite good and that he's improving, because I can see by what he does, how he works out the questions, what methods he has and stuff.

Rachel: Okay, and Aymil?

Ben: I put him there – he is my friend, well he's good at maths but he copies me sometimes so I put him there, and he works out some questions that I can't work out, that's how I know he's there.

Rachel: And Gaby?

Ben: Because when we get in some groups in our maths groups, I was partnered with her one time and we had this question and we had to show our working, this really big working and she done some of it and I done some of it.

Rachel: Now, is there anything that's similar about Nabiha and Gaby in maths but different from Aymil?

Ben: Yes, they're both quite good at their methods, Nabiha and Gaby, using their methods how they've been taught, how they work it out.

Rachel: What about Gaby and Aymil? Is there anything that's similar about Gaby and Aymil in maths that's different from Nabiha?

Ben: Well in maths Aymil and Gaby they talk more, but not maths, they, well Nabiha does more maths and Gaby and Aymil they might be talking more about just other stuff, especially Aymil but also sometimes Gaby.

Rachel: Okay, so if we take Aymil again, can you tell me how Aymil and Nabiha are similar in maths but different from Gaby?

Ben: No there's nothing the same about them, I just know that Aymil argues. Aymil is very different because sometimes he's not concentrating that well and he's doing something else but if he puts his mind to it he can do it.

Rachel: Okay, now where would Miss Barton put you on the line?

Ben: Here, about here somewhere, because when I done my Thameside tests for Thameside Grammar I had, my Mum, I didn't know this stuff that I had before, this non-verbal and verbal so my Mum started to study for me, every day for six months every day, seven hours and then I got better and better, and my teacher uses that.

Rachel: And where would you put yourself?

Ben: About there, because I have been studying with my Mum nearly every day and I study with her a lot and I improve and I improve on my methods and sometimes I don't know the question so I'm not perfect and I'm kind of okay and that's it.

Rachel: So you're here, could you move?

Ben: Yeah, I guess I could, well if I like don't study at all for three or four weeks I might go down and if I keep studying I might go a bit higher. And maybe forgetting how to do division or not knowing my times tables and how to, showing methods in places where I have to show my methods would make me go down and if I be like naughty or stuff and interrupt.

Rachel: Now do you know anyone, doesn't have to be in year 6, who might be at the 'best' end?

Ben: Yes, because they're very, in my, in that person's country, cause he is like, because I used to study there and it is very strict study so, if like, here the stuff you do in year 4 you would do there in year 1.

Rachel: And do you know anyone at this end?

Ben: No, I can think of someone here, because they're only young, they'll move when they get older.

Rachel: Okay, how do you think your teacher would decide where to put people?

Ben: I think it would be difficult because there are a lot of people who are good at maths in the maths group and they all have a different way of working out, so from our tables, our levels, and also because, because let's say if someone is really bad at maths or used to be and the next thing you know he is a bit better so he might move up a little bit.

Rachel: Right, now the next thing I have, I have a picture of your classroom, where do you sit for maths?

Ben: For maths I sit here.

Rachel: Why do you think your teacher put you there?

Ben: I dunno. Maybe because the people there are sort of my level, my level in maths is close to that level.

Rachel: What are levels?

Ben: It's like 4A, 5A and stuff like that, it's your grades, meaning how good you are. At the end of the year they have SATs and they show you, last year I got 4A which is good and this year I'm hoping to get 5A, or a 5 level and I think she put me there because most of the people are level 4. She puts different levels on different tables, I think, I think she puts, I'm not sure, but these are 3As, level here, they're close to the teacher so that she can explain a bit more, and this is kind of the 4 and 5 middleish, these I would say 4, these are 4 ½ levels.

Rachel: Why do you think she does it like that?

Ben: To get along with other people, maybe they're not your friends but then you can get along with them, you can get on with people of any level but she puts us together. Also because each table doesn't get the same work, like she gives us A, B and C sections on our work, and A is like a bit easier, B is in the middle and C is hard, we start from A, then we go to B and C, but if, sometimes she says this table, don't start from A, start from B, because they are a higher level and she wants them to do more.

Rachel: Okay, last task, I've got a picture of a year 6 maths class. I want you to imagine this is you in your maths class and draw in your face to show me how maths makes you feel. You can write or draw in the speech bubble to explain how you're feeling too.

Ben: I'd feel kind of in the middle because I don't like maths and I don't always feel like it. I'm kind of, not happy or sad, just kind of straight like this. Well sometimes I don't really really act, because if I say "ahhhh", she says, come on, don't do that, and I don't want to stand out ever even if I'm really happy, so I make no reaction and she doesn't say anything and I just get along with my maths. I really don't want to stand out, I just don't. I would feel okay about being in my maths lessons, not really like really happy or really bad, just sort of in the middle. If I don't try to stand out, the teacher, she doesn't say anything, which I guess is my plan, it's like what everyone does. Some people which are not really like that say "ohhh" and some sit quietly.

Rachel: Okay, that's all my questions. Is there anything else you want to say about your maths lessons?

Ben: Yes, I really enjoy them and sometimes it's, it helps my brain to get active so I'm not bored or something and I have something to do and that's it.

Rachel: Okay, well thank-you for talking to me.

Pupil Group Interview (partial transcript example)

GROUP PUPIL INTERVIEW

Date	**29th April 2008**
Time	10:40am
School	Avenue Primary School
Class	Year 6, Set 1
Pupil Pseudonyms	Megan (HA), Natalie (MA), Olivia (LA)
Interview No.	5
Special Notes	Group interview conducted immediately after a mathematics lesson. Each pupil had already been interviewed individually previously.

Rachel: Okay, thank you for coming to talk to me again. What I would like to start with this time is to talk about your groups that you are put into for maths. Can you tell me a bit more about that?

Megan: Well partly it's because some people like are of a low ability and might not do as well as the top group in an activity and so they might feel bad, so if they are put into a range of groups then they'll all be able to do the same work and not be given different types.

Olivia: Yeah like they all can do the same work at their ability and then build up on that instead of starting on something which is too difficult for them or the teacher having to lay out different things for different pupils in the class because of their abilities.

Rachel: What does abilities mean?

Olivia: Different, it's what they find hard and stuff like that

Natalie: Yeah, how good they are at a subject or how much they struggle with it, stuff like that.

Rachel: And have you always been put into different groups?

Megan: Yeah

Natalie: In maths, definitely in maths

Olivia: In year one we were all the same, but people just got different work and they sort of realised what we could do, see what was a bit hard

Natalie: I think in year two they started one top maths group and the rest were taught in one or two groups and then in year three we went into five different groups.

Olivia: It's sort of pressured though, because we just sort of sat there waiting for them to say our name, like, in the top group is you, you and you and you're just waiting for someone to say your name and you don't really know if you have done well or if you have improved from the last test of something.

Megan: Because in Year 2 when they get your results for year 3 so they know which group to put you in, but if they say some names and you don't hear yours, you're always wondering, oh, have I done really badly.

Olivia: But I don't think most people since year 3 haven't moved down a group, I think a few have moved up, but I don't think many have moved and some have definitely improved, because like you see your buddies and everything and my buddy said she had like trouble with doing certain like maths things and I said to her once how's your maths going and she's like it's going much better because people have explained it to me.

Natalie: I think people can go down

Olivia: Maybe if you get under 20 on a test

Megan: It's like if you make like, if your previous score and if people get more than you, like if you're in group 2 and people in group 3 get more than you, like two people in group 3 get 33 out of 40 and you get 30, then you would be moved down.

Olivia: I thought it was if you got under 20 you got moved down

Megan: But what if lots of people got under 20?

Olivia: Then they'd be moved down.

Natalie: I think it's not all to do with tests, it's mainly, but also class work because one of the important things is how you are doing with your class because if you are way behind you will find it hard to catch up the rest of the group and that can be quite embarrassing sometimes because you are behind everyone else and can't catch up and you get kept in to do extra work and stuff like that.

Olivia: It's really terrible when someone calls on you and you don't know an answer, I used to do that all the time, I never used to be listening or something and Miss Gundry was like what's the answer, then she would just pick someone at random, you, and then I used to get it wrong and it was embarrassing.

Megan: I think it's more embarrassing for the people who are, who know, who are good at maths and they get something wrong, like today because Martha was doing the maths the other way she got the answer wrong and because she's quite good at maths [Olivia: yes she is] the class were going ooohhh and boooo.

Olivia: Yeah and like, especially if you get an answer wrong then everyone shouts no, no, no and they go yes yes yes, it's quite like, it's like a zoo in the classroom it's terrible.

Megan: Yeah if you get an answer wrong everyone goes nooooo, it's this, and everyone goes, yeahhhhh.

[Interview continues…]

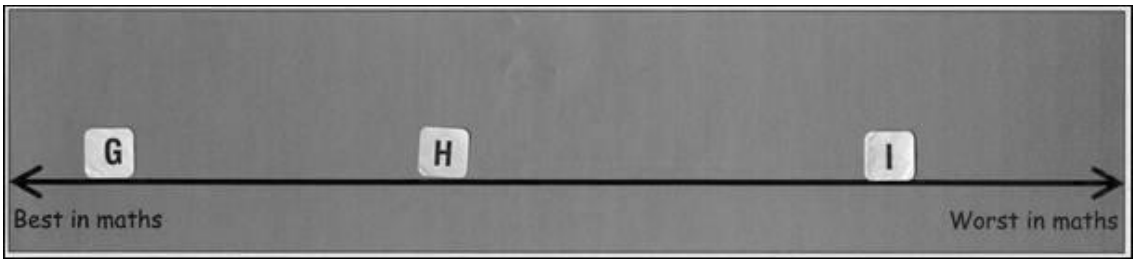
Teacher PCT Individual Interview (partial transcript example)

INDIVIDUAL TEACHER INTERVIEW

Date	**Monday 21st July 2008**
Time	2:00pm
School	Parkview Primary School
Class	Year 4 (Mixed ability)
Teacher Pseudonym	Mr Donaldson
Interview No.	Teacher interview 6
Special Notes	

Rachel: Thank you for taking the time to talk to me. What I would like to begin with is to think about the three children I've been working with this year: George, Helen and Ivy. What I'd like you to do, it's similar to the line on the questionnaire you did with your class. If this line is all of year 4 at this school [Mr Donaldson: at this school, yeah] could you put George, Helen and Ivy on the line where you think they go for me.

Mr Donaldson: Okay. Well is starts very easy, so in year 4, he would go right up there, Helen, interesting in terms of her confidence, Helen would be, you know, she'd be kind of, round about, up just above the middle, though I would suspect that she would think, possibly, that she's a little bit less than that. Ivy would be someone who has come on, has again, has more ability than she will show, whether that's confidence, or, you know in terms of wanting to do it, but she's far from the least able in the year-group, but you know, needs a lot of progress to develop further. So, somewhere there I think.



Rachel: Great. As we were talking about Ivy, can you say a bit more about how you know she goes there?

Mr Donaldson: Now Ivy is interesting, you know I often do the, in general maths lessons where we have the little whiteboards out, there will be days where she appears to know hardly anything but unfortunately that can, she's not, that's when she's not so focussed, when she's focussed I can just see in the answers that she produces on her whiteboard that she has got an improving level of maths. When I work with her individually, I can, you know, she will suddenly, well group work I work with her and she's the most able in that little group that I work with and she'll say to me, oh that's easy, whereas in class, as a class she'll say, oh I can't do that when I know that she can. And her test at the end of the year has again shown that she's above the level that she thinks she is and so that score in itself has done that, so those three or four things helped me.

Rachel: And how would you describe her in a typical maths lesson?

Mr Donaldson: Reluctant. She's a reluctant mathematician. She'll be somebody who on one day it will be more, if she doesn't understand it straight away then she'll, that's it, I can't do it, she needs a lot of, you know as soon as you can see that she has done something well get in there, make her feel good, be very positive with her, you know it's not always easy, but that's what one needs to do and again that moves her on a little bit, yeah, she'll often say oh I just don't like this and that's that but once she gets on with the work she's much better.

Rachel: You talked about her not having as much confidence; do you know where that might come from?

Mr Donaldson: Oh goodness, erm, I'm not sure she has the most positive experiences at home in terms of you know, encouraging her to take part in activities like this and to be told, you're doing really well and stuff, so it's that kind of attitude to the maths or the learning in general.

Rachel: And Helen. How did you decide to put her there?

Mr Donaldson: Yeah, I mean again, from whole class work, you can see the answers, she thinks about her answer very carefully, she won't be the first to put it up there so I can see her really thinking it through and will then eventually show me, yep, well generally, most of the time able to work out what it is I'm asking, her work suggests that, you look in her maths books, you know I can see that she generally is able to work it out whatever the concept may be, group work again, and her test results again have shown you know, she's average for her maths, she just, she will lack confidence.

Rachel: Yeah, because you said at the beginning that she wouldn't put herself there; where do you think she would put herself?

Mr Donaldson: Yeah, she may, well she wouldn't put herself down there, I'd say maybe there, I could actually have put her maybe just a little bit higher as she has more confidence now as the year has progressed generally and hopefully, maybe not in maths as much as other subjects, but I think she's you know, in fact I'm going to move her just a bit, I don't know if I'm supposed to.

Rachel: That's fine. What was behind moving her?

Mr Donaldson: Because I just suddenly realised, she's just a little bit better than average and I kind of had her right in the middle there almost, didn't I, I wouldn't say she's incredibly above average but she's more than capable.

[Interview continues…]

Appendix N: Data Coding, Categorisation and Axial Coding Process

In this appendix, I explain the data coding and selection discussed in Chapter 4. I use a section of the individual interview transcript included in Appendix M to illustrate the process.

Open coding

Each transcript was open-coded in NVivo using constructivist grounded theory. This process involved immersion in the data and attaching codes to data segments. Coding was continued across the data set until a position of data saturation was reached whereby no principle new codes were being produced (Strauss, 1987). I recognised that further data collection and more intense coding may have yielded further codes, but the coding completed was deemed appropriate and satisfactory given the constraints of 'practicality' (Ball, 1991).

The open-coding was all completed in NVivo. The screenshot in Figure 31 illustrates how the codes were added and the code types. The coding strips applied are shown at the side. This is only an example and shows the codes most applied to this document.

As the coding, and hence the number of codes, increased, it became important to tidy up and justify the codes applied. At several times during the coding I went through a process of cleaning my codes. This involved exploring how the codes produced were different from other codes and looking particularly at codes with relatively little data attached to them in order to ascertain whether they were important and whether they could be included elsewhere or merged into another code. In conducting this process I was continually having to justify the codes used and this also served to make the coding more manageable.

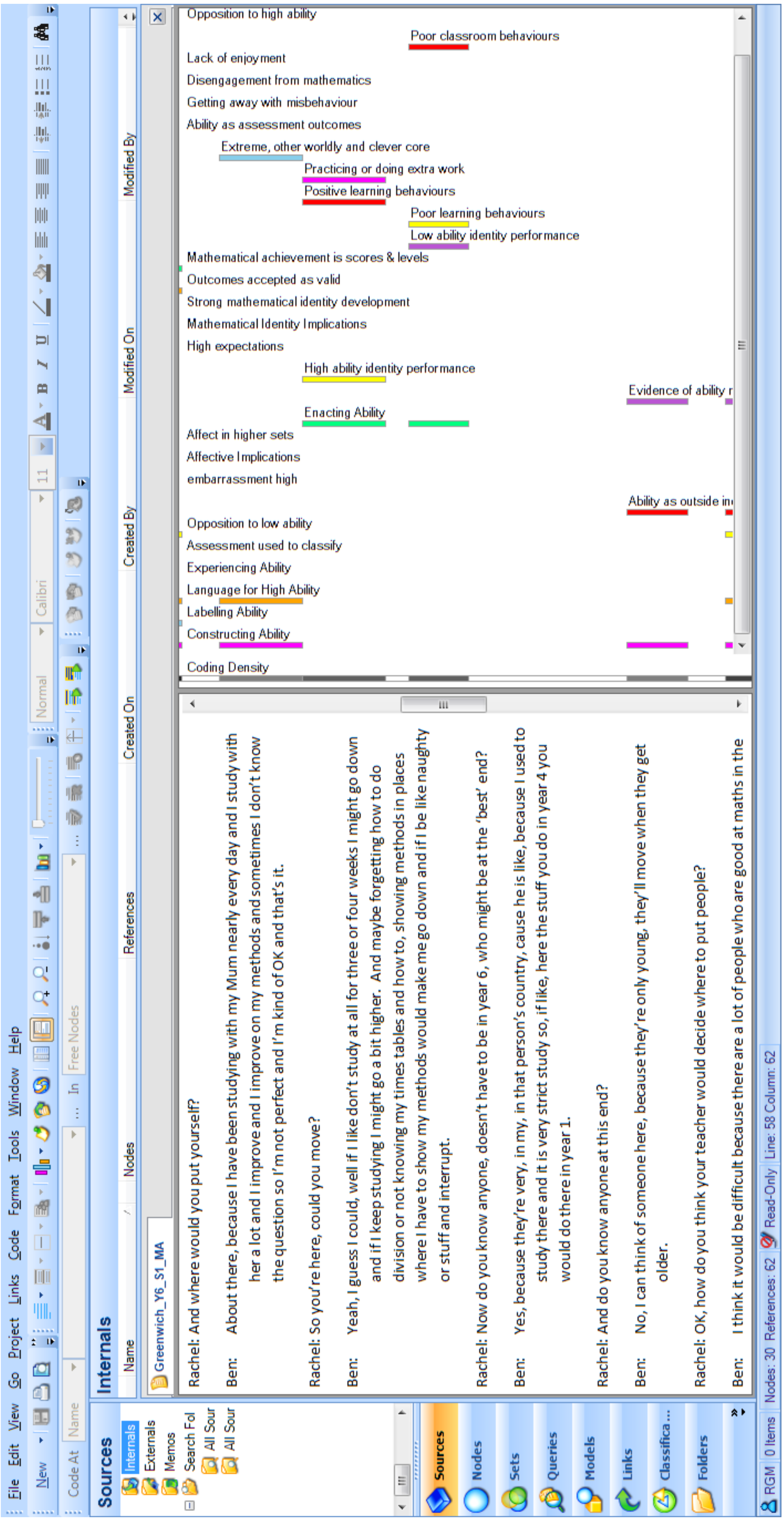


Figure 31: Transcript coding in NVivo

In order to ensure consistency of code application, I wrote code descriptions for each code explaining what its intended meaning was, any circumstances when it would not be used, and an example of data the code had been attached to. In writing these code descriptions, some apparent duplicate or similar codes emerged, and were examined to determine whether to keep, merge or remove them. For example, my early coding produced the nodes 'being bottom' and 'being worst'. These both appear to relate to the low position of the pupils in the class and neither had vast amounts of text attached. I began by exploring how they were different from each other and from other codes.

Other codes were found which also appeared to carry similar meaning, for instance 'being lower', 'not being best'. However, looking at the text attached to the originally considered nodes suggested a specific difference between the two: 'being bottom' referred to class positioning by self/others or classroom structures and occurs in relational or comparative discourse, whereas 'being worst' relates to self-belief and although may still be comparative is not related to specific class positions or ability structures. In order to record decisions made regarding particular codes, notes were added to the code descriptions and tree node properties (Figure 32).

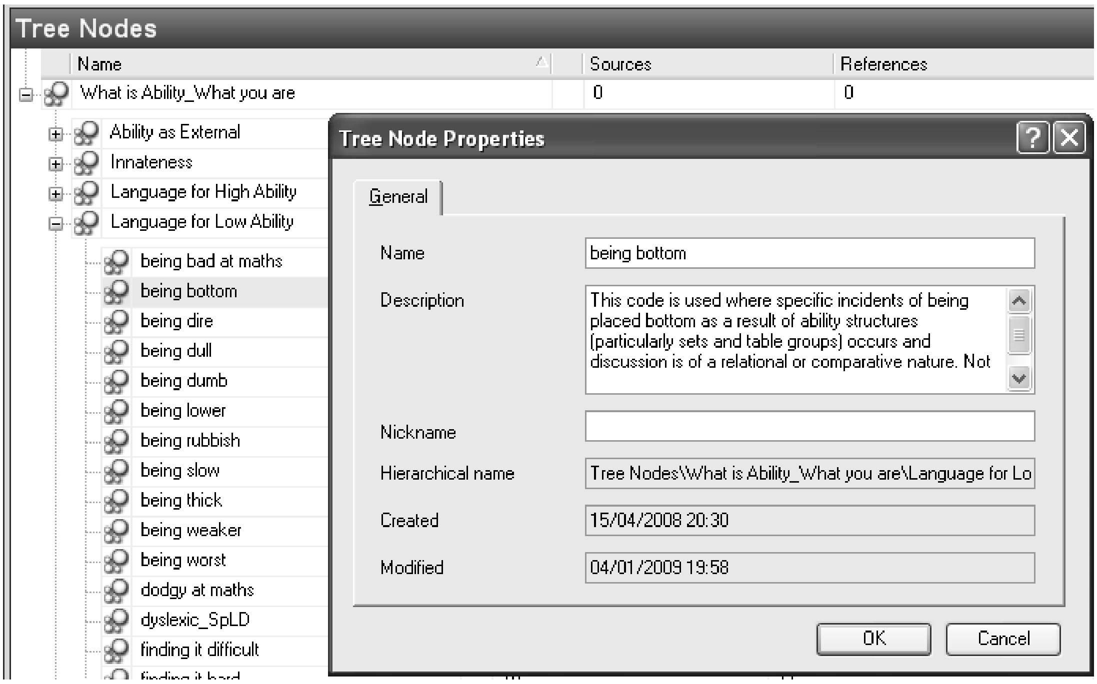


Figure 32: Tree node properties in NVivo

As part of the stage discussed above, I merged codes where one seemed redundant. This was then extended using the 'comparing and combining' strategy as outlined by Bazeley (2007, pp. 163-164) to explore whether there were discernible differences within the text attached to different nodes and if not, to find a way of combining them that still covered the original intention of each node. For example, 'finding it difficult' and 'finding it hard' both appeared to be coding the same type of occurrences. These nodes where therefore merged to form the new node 'finding the work hard' with the adjective 'hard' kept as this was the language used by the pupils/teachers in the majority of cases.

Tree structuring

As I open-coded I began to structure the codes into trees aiding manageability and reflecting previous analysis methods. Tree production also involved a process of cleaning and justification. I took each node in turn and attempted to justify why I had placed it within a particular level within a particular tree. This was achieved by challenging the positioning and asking whether it fitted in any other level/tree, with memos written and attached to specific nodes/groups of nodes. In some cases nodes needed to be moved whilst in others it was deemed more appropriate to have the same node within two (or more) separate trees. As a further check, I produced tree node coding charts within NVivo for each parent node in order to explore the sources of the text coded within the group. This allowed me to ensure the node had been applied to all sources, and if there were gaps, to go back to the original transcripts and check the original coding. The culmination of this process was four distinct trees or parent nodes – constructing ability, enacting ability, experiencing ability, labelling ability – each broken down into multiple sublevels. An example of one coding tree is shown in Figure 33, showing the different levels used.

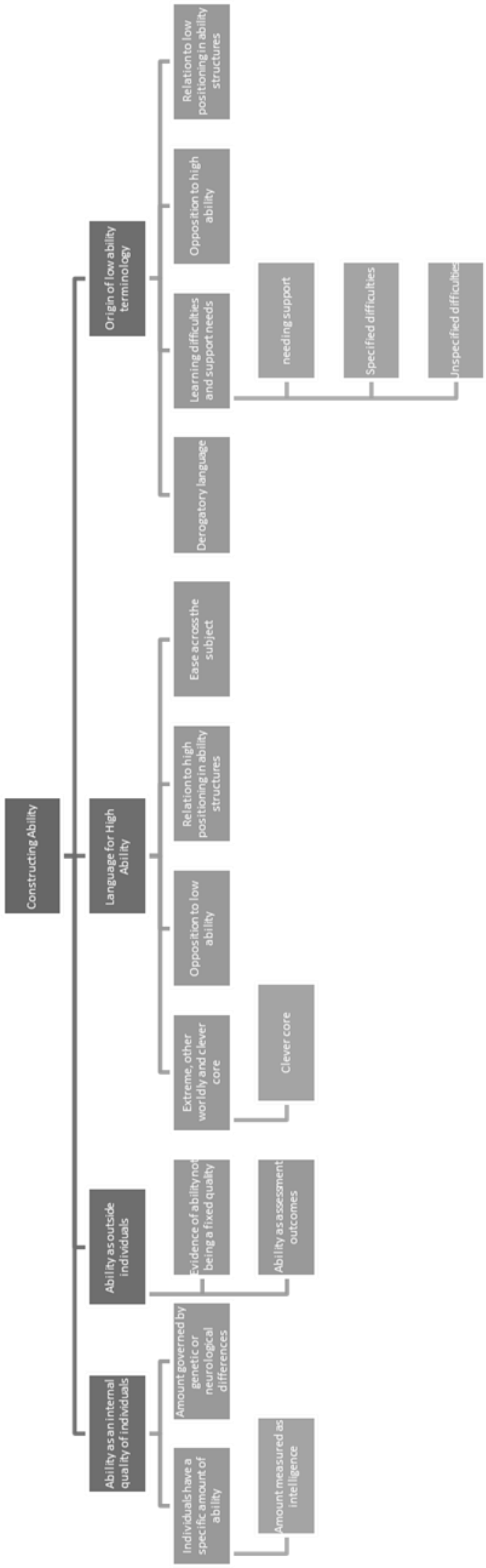


Figure 33: Coding tree

Axial coding

Axial coding involves a move from the descriptive 'what' level of open-coding to conceptual 'how' and 'why' questions in coming to understand the relationships within the data.

I began by using NVivo and the data produced within NVivo in other programmes to explore the strengths of the different nodes and tree levels in terms of the quantity of data attached to them and the location and strength of relationships between the nodes. I produced scree plots (see Figure 34) showing the data attached to all nodes and additionally at each tree level and with each expanded tree. This allowed me to identify the most salient concepts/nodes within each level which served as starting points in exploring relationships.

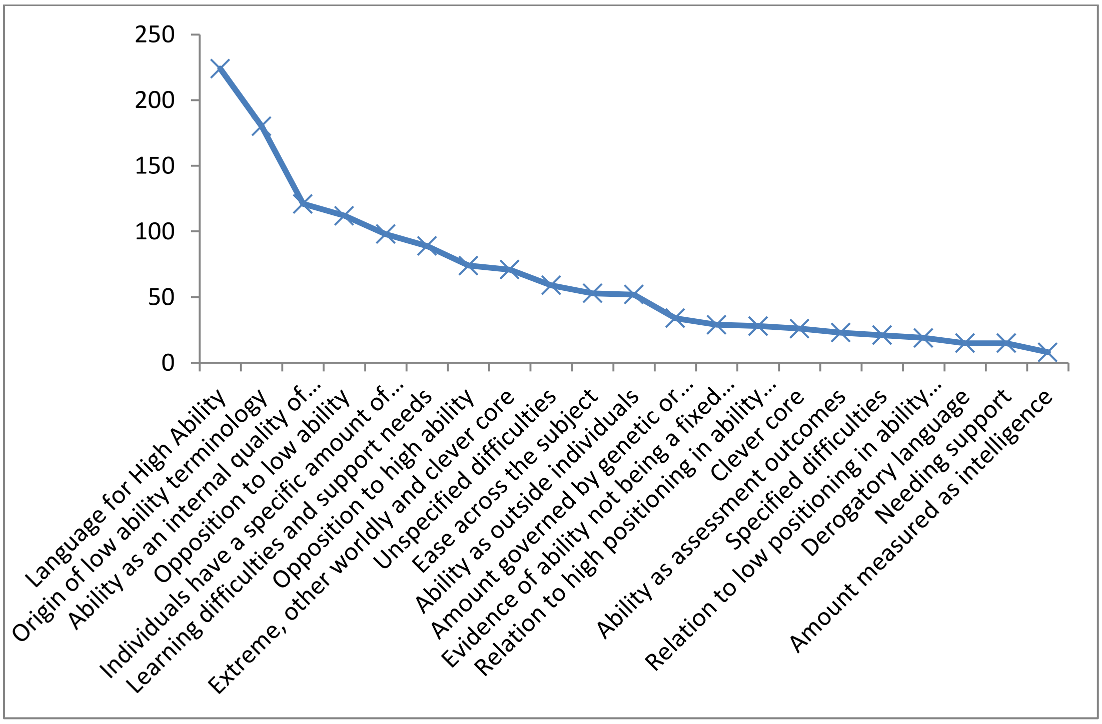


Figure 34: Data-coding scree plot

I then conducted a number of matrix coding queries in NVivo. A complete code-by-code matrix showed the extent to which data had been attributed to every possible pair of codes. This matrix was imported into Excel and colour coded using different shades of the same colour for each tree to visually illustrate the strength of the relationship between each code pair. This was obviously a large chart, although Figure 35 gives an indication of what this looked like overall and how colour saturation indicated code relationships.

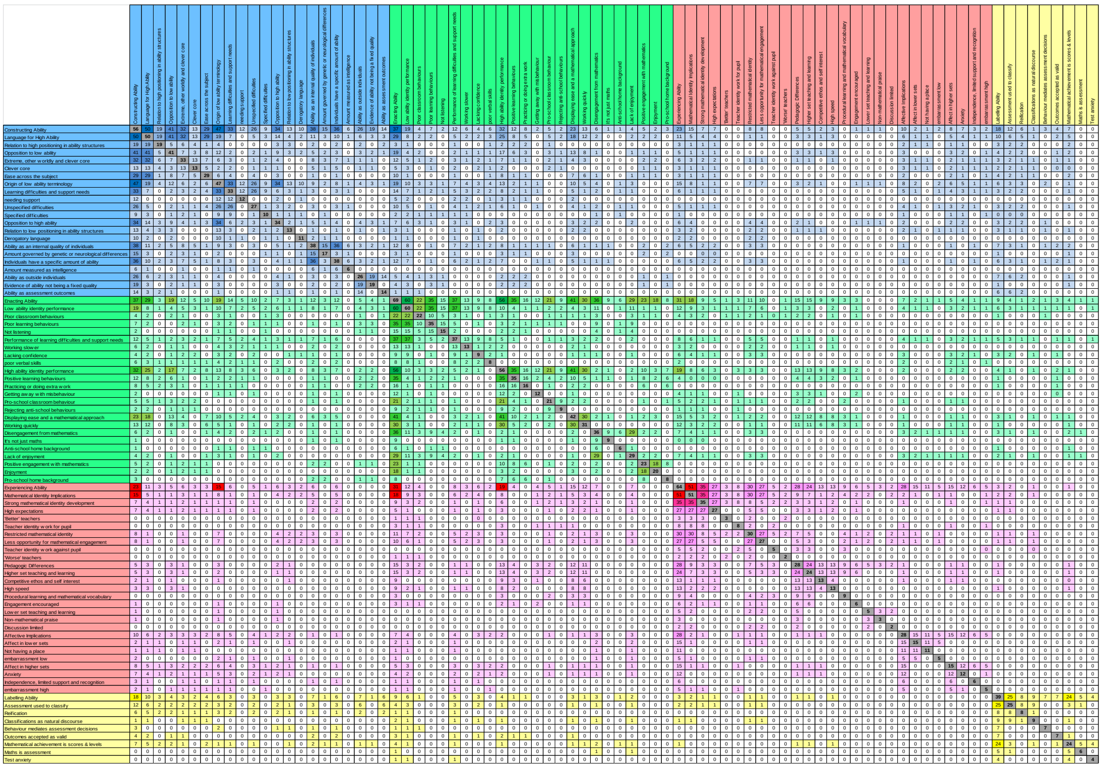


Figure 35: Code-by-code relationship matrix

I also conducted attribute-by-code matrices for each tree, mapped to each data attribute and level: class/set position, data type, gender, school, set and year. These were also colour coded as for the code-by-code matrix to show the strength to which each level of each attribute related to each node. It was possible from this to get an overall view of where different nodes were stronger, for instance in showing that ability is experienced more strongly in the set (Avenue Primary) than the unset (Parkview Primary) school.

I then used mapping and modelling software, similar to the modelling feature in NVivo, to axial code across the dataset. I imported the four trees in a 2 x 2 arrangement then used the results from the scree and matrix queries to draw in links, which were directional if required, between nodes. In many cases I returned to the data attached to pairs of codes to explore how they were linked and then added notes to the links in the model. In addition, links to other data were added, for instance possible triangulation with aspects from the attitudinal questionnaire as well as links to memos written throughout the analysis stage. In some cases, sub-themes emerged. Although these did not match particular codes as they did not appear directly in the participants' language, they represented some key ideas in the literature and acted as possible links between nodes and as possible explanations for relationships. One such sub-theme was care/control. This appeared to link the nodes regarding teacher identity work as well as nodes related to expectations, classroom experiences and the possibility of developing a mathematical identity. On completion, the axial coding produced a complete overview of how all the data nodes and their structuring trees were linked as well as beginning to draw out further possible themes. An illustration of this model is shown in Figure 36 (the original model is 2A0 in size). For clarification, an enlargement of a small area to show the axial-coding detail is given in Figure 37. This mapping is quite messy, representing Ely et al.'s (1997, p. 20) suggestion that data analysis will be 'multiple and multi-layered and blurred at times'.

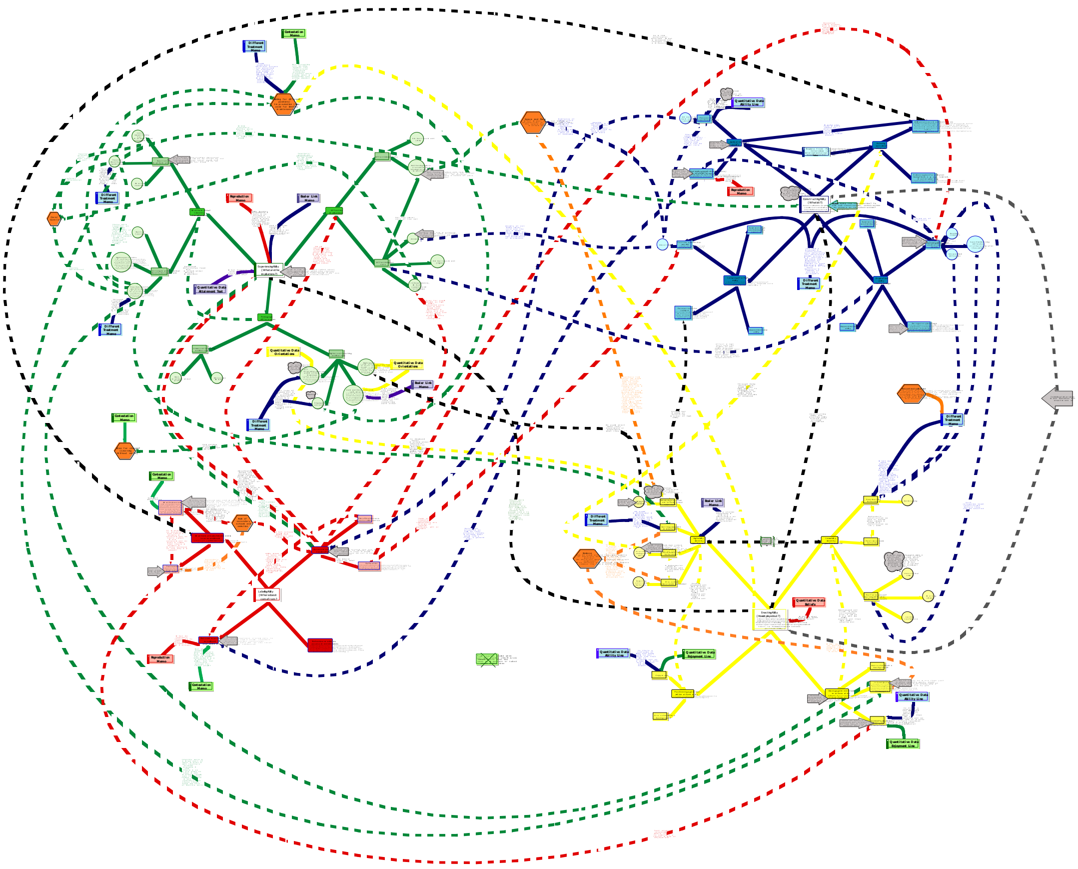


Figure 36: Complete axial-coding model

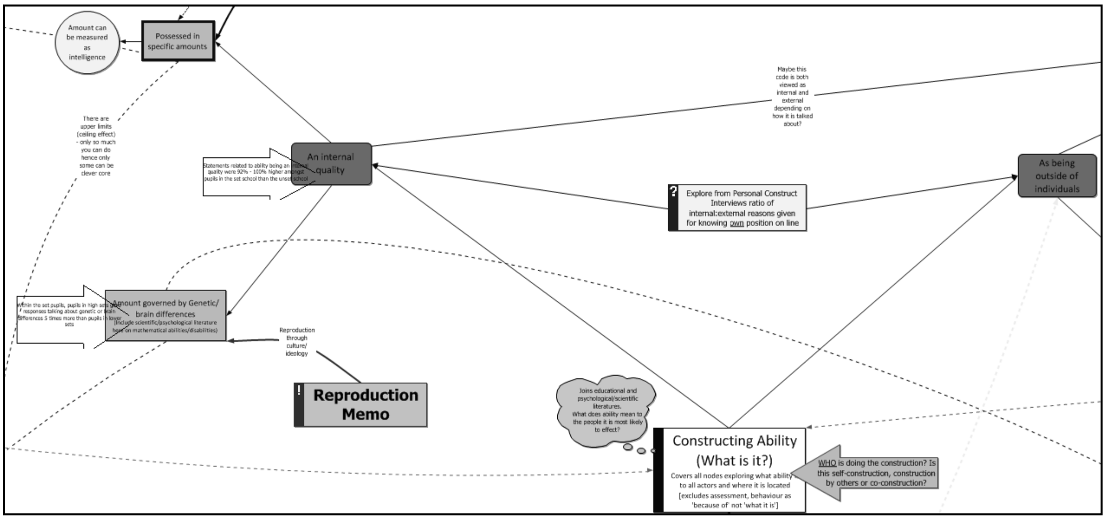


Figure 37: Enlargement of axial-coding model segment

Data selection

Major themes which emerged from the axial-coding were related to the research questions and summary overviews produced to enable the development of the analysis into coherent sections which then formed the key themes for the data discussion.

As data was attached to each theme during the coding, sorting and analysis process, this could be extracted to illustrate the themes discussed, with the axial coding also highlighting links with other data, including quantitative data, exploring the same theme, allowing for triangulation.